Science 20

MODULE 3

Matter and Energy in the Biosphere

Distance Learning

Alberta EDUCATION

Science 20

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Distance Learning

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Module 3
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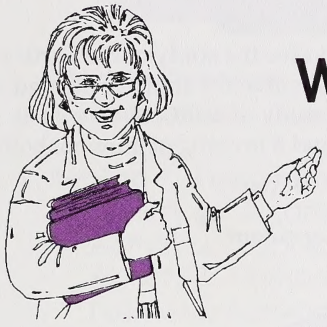
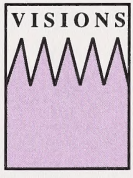


Welcome to Module 3!

We hope you'll enjoy your study of Matter and Energy in the Biosphere.

To make your learning a bit easier, watch the referenced videocassettes whenever you see this icon.

When you see this icon, study the appropriate pages in your textbook.

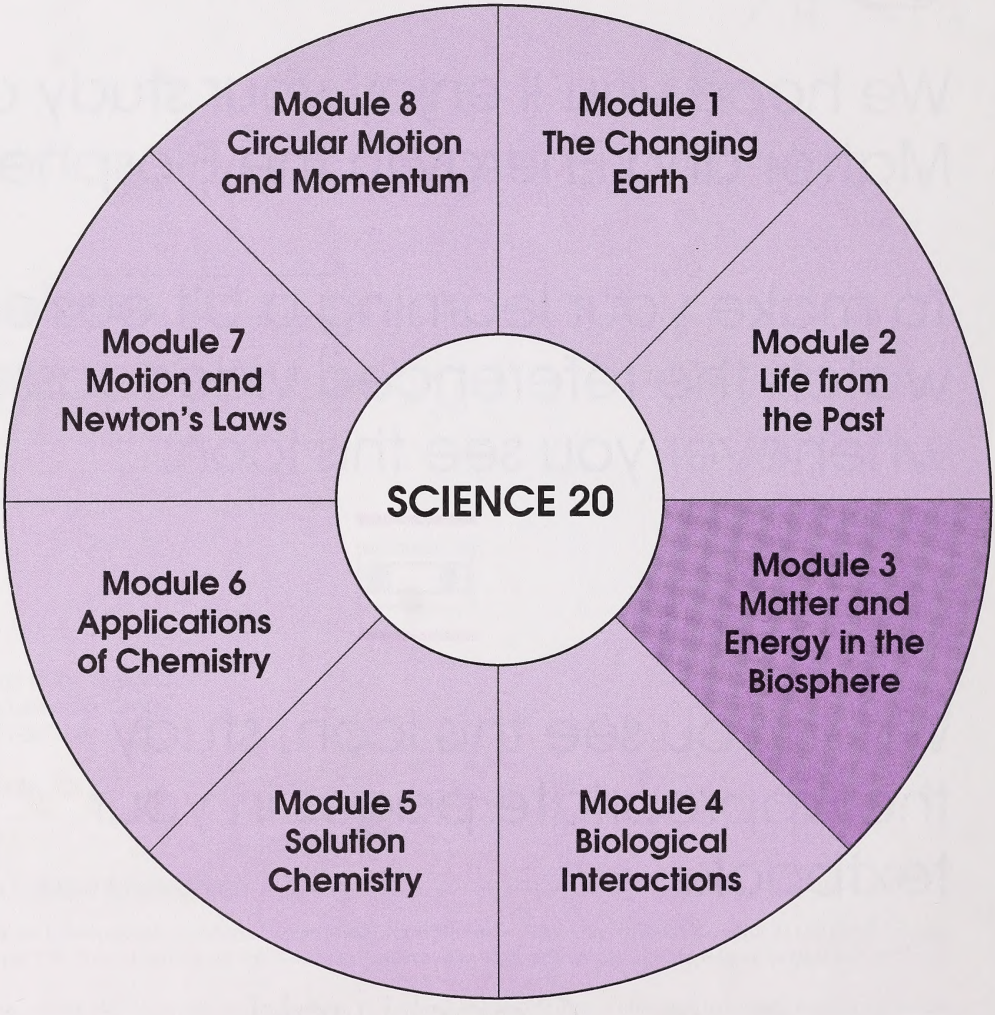


Good Luck!

COURSE OVERVIEW

This course contains eight modules. Modules 1 and 2 involve the study of the Earth's physical features and past life history. Modules 3 and 4 involve the study of life and its interaction with the Earth. Modules 5 and 6 involve the study of solutions as well as how chemistry is used for everyday things. Modules 7 and 8 investigate motion, both on Earth and in space.

The module you are working on is highlighted in a darker colour.



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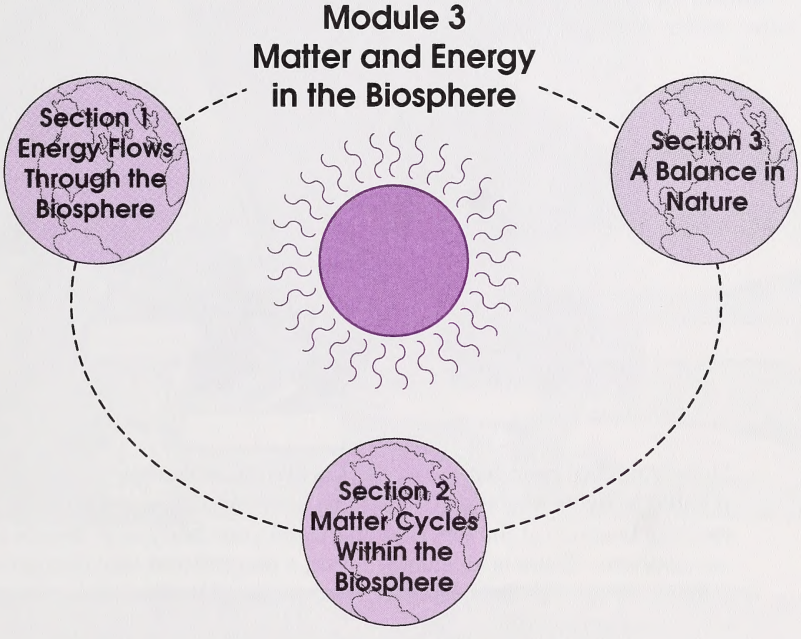
MODULE OVERVIEW

Have you ever been outside on a moonlit night and gazed at the stars? Do you wonder if there are other planets like Earth where life exists? What are the conditions that provide a suitable environment for living organisms? How many other places in the universe could also support life?

To answer these questions, scientists have discovered laws of nature that help provide an orderly arrangement to the world around us. In Modules 1 and 2 you examined the cyclic changes that have occurred in the biosphere during the history of the Earth. In this module you will investigate the energy flow and cycling of matter that create a delicate balance in nature. Biological systems can change over time, but life in its many forms continues to thrive on planet Earth!



Evaluation

Your mark in this module will be determined by your work in the Assignment Booklet. You must complete all assignments. In this module you are expected to complete three section assignments. The assignment breakdown is as follows:

Section 1 Assignment	**40 marks**
Section 2 Assignment	**30 marks**
Section 3 Assignment	**30 marks**
TOTAL	**100 marks**

Section

1 Energy Flows Through the Biosphere

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Have you ever been hang gliding, skydiving, or bungee jumping? You may even have wanted to drive a race car! These are not everyday events for most people. Each one is exciting because of the forces acting upon your body as it speeds through the atmosphere. There is an energy input, a magnificent transformation, and a subsequent output. When this flow of energy is over, people often seek to repeat the process again and again and again!

In this section you will investigate a different flow of energy within the biosphere. Solar energy enters the atmosphere and is transformed into chemical energy; then, it is transferred from one organism to another until it returns to the atmosphere as heat. You will examine how this energy is captured and utilized by different organisms as it fuels the biological processes which occur in the biosphere.

Activity 1: Organization Within the Biosphere

In Science 10 you learned that the biosphere is the portion of the Earth where living organisms are found. You also learned that the energy from the sun creates the conditions that are necessary to support life.

VISIONS

To begin the study of the biosphere, read the introduction to Chapter 4 on pages 114 and 115 of *Visions* 2. When you are finished reading, answer the following questions.

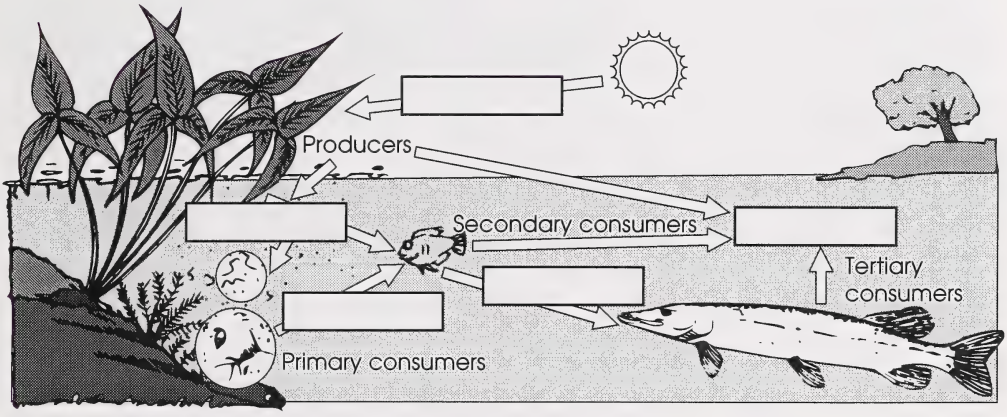
1. Why is the recycling of matter important in the design for living?

2. The following flow chart summarizes the basic pathway of energy through the biosphere. Label each of the boxes of the flow chart using these terms: **solar energy**, **chemical energy**, and **thermal energy**.

solar energy – the continuous flow of energy from the sun

chemical energy – useful energy stored in molecules that can be used for the work of the cells

thermal energy – heat energy which is lost into the atmosphere



Check your answers by turning to the Appendix, Section 1: Activity 1.

No organism lives completely on its own. It depends on other organisms and the non-living environment in which it lives. Studying the relationships within the biosphere begins with understanding the levels of organization that exist. Biologists organize the biosphere in order to more clearly understand the flow of energy and the cycling of matter.

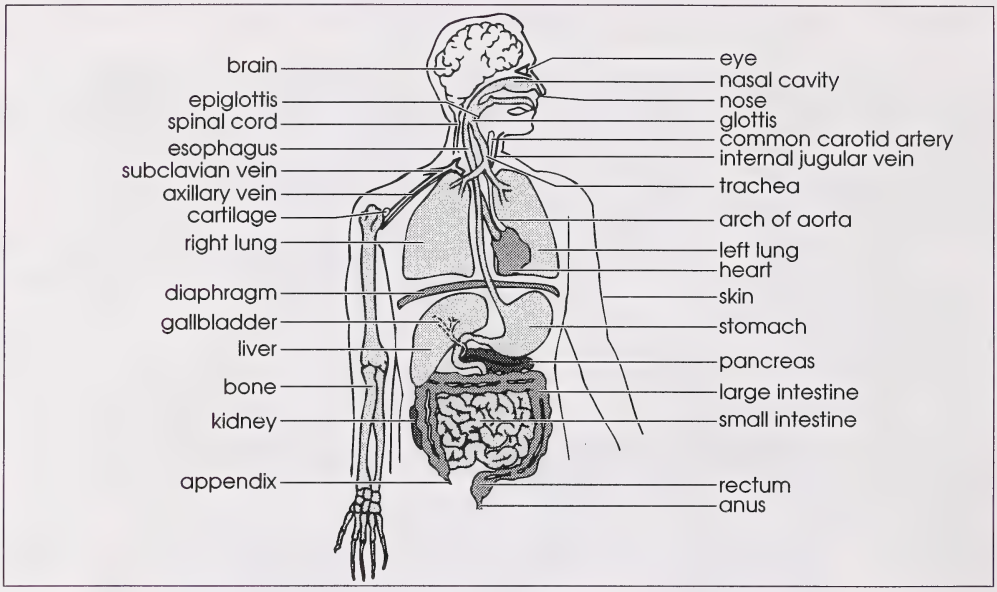


FIGURE 3.1 Levels of Biological Organization in a Human

cells – the basic structural and functional units of life

tissues – groups of cells that perform the same function and look alike

organs – groups of tissues that work together to perform the same function

organ systems – groups of organs that work together to perform the same function

All living things are made of **cells**. In human beings, cells are organized from **tissues**. For example, muscle cells are organized into muscle tissue. Tissues are organized into **organs**. Your heart is an example of an organ. It is made up of muscle tissue, nerve tissue, and other tissues. Organs work together to form **organ systems**. Your circulatory system is an organ system. It consists of your heart, arteries, capillaries, and veins. Finally, the organ systems are organized into an organism such as yourself.

3. List two organ systems you observe in Figure 3.1.

4. For each of the two systems you listed in question 3, identify two organs within each system.

5. Does each organ have nerve tissue, muscle tissue, and other tissues as the heart does?

Check your answers by turning to the Appendix, Section 1: Activity 1.

FIGURE 3.2 Levels of Biological Organization in a Pond Ecosystem

population – a group of individuals of the same species that live together in the same area

community – all the living things in a certain area

ecosystem – a self-regulating system of interactions between living and non-living components

biotic – relating to the living components within ecosystems

abiotic – relating to the non-living components within ecosystems

The levels of life do not stop at the organism. That is because no organism lives completely on its own. Its interactions with other organisms and its environment form levels of biological organization beyond the organism level. A **population** is a group of individuals of the same species living together in the same area.

6. Identify three populations you see in Figure 3.2.

A **community** is all the living things in an area. A community consists of many populations. An **ecosystem** is an interacting system that consists of the community and its non-living environment. Therefore, an ecosystem has a **biotic** or living component and an **abiotic** or non-living component.

7. What is the major abiotic component of the ecosystem shown in Figure 3.2?

8. What are some of the other abiotic parts of the ecosystem in Figure 3.2?

9. Make a chart similar to the one that follows. Using the information shown in Figures 3.1 and 3.2, complete the chart with appropriate examples.

HUMAN BEING		BIOSPHERE	
Level	**Example**	**Level**	**Example**
cell		organism	
tissue		population	
organ		community	
system		ecosystem	
organism	human	biosphere	all life on Earth

Check your answers by turning to the Appendix, Section 1: Activity 1.

Science Skills

- ☐ A. Initiating
- ☑ B. Collecting
- ☐ C. Organizing
- ☑ D. Analysing
- ☑ E. Synthesizing
- ☐ F. Evaluating

Familiarize yourself with the following questions and then view the ACCESS Network video entitled *Aspects of Ecology: Ecosystems*. As you view the video, answer the questions. Pause the tape whenever necessary to write your responses.

10. List six features of an ecosystem.

11. What makes a tropical ecosystem different from an arctic ecosystem?

12. As humans attempt to manage ecosystems, they often alter the natural factors. Give three examples where human interventions have benefited ecosystems.

13. How has the addition of **phosphates** to the water systems of Calgary and Edmonton affected the surrounding ecosystems?

14. Name two sources of **acid rain** in Alberta, and explain the effect of lower pH values on the ecosystems.

15. What is the purpose of **reclamation**?

phosphates – complex ions of phosphorus that can be used to make nutrients

acid rain – the result of pollution in the air that decreases the pH of the water which descends as rain

reclamation – the process of returning aquatic ecosystems to their original state

Check your answers by turning to the Appendix, Section 1: Activity 1.

In Section 3 you will learn more about the abiotic factors within an ecosystem, and in Module 4 you will study the variety of interactions among the populations within an ecosystem. The health of the biosphere is affected by the activity within all the ecosystems just like your health is determined by the successful functioning of all your organ systems.

In the activities that follow, you will learn more about the flow of energy through an ecosystem. The transformations and transfers from one population to another will be explored. Usually there is a balance in nature, but sometimes the influence of man destroys this balance, as you will see.

Activity 2: Trophic Level Teamwork

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Have you ever been a part of a team? Was the team successful? What factors contributed to the success or failure of your team? Was the experience a rewarding one? Championships are never won by individuals. There is always a group of people working together that brings out the best in everyone. Team sports can work effectively when the role of each member of the group is fulfilled. If this does not happen, there is usually conflict that eventually leads to failure.

Just like a team, each population within an ecosystem has a job to perform. The success of an ecosystem depends on how populations interact with one another. There are three important roles that must be performed properly to ensure an efficient flow of energy and matter within an ecosystem.

VISIONS

Since food contains energy and matter, the roles of populations in an ecosystem involve feeding relationships. To begin your study, read Energy Flows in One Direction Through Ecosystems on pages 115 to 119 of *Visions* 2. When you have finished reading, answer the following questions.

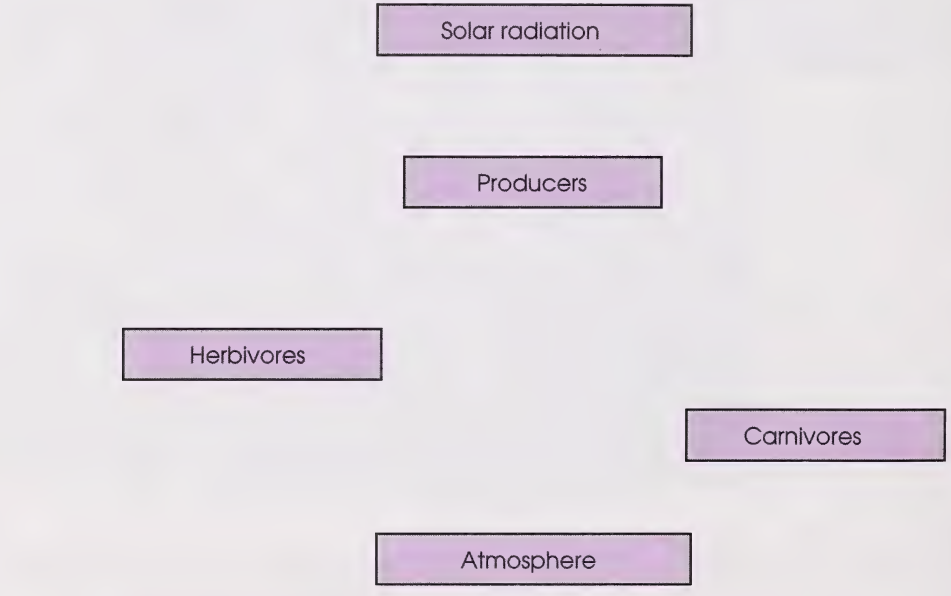
1. Define each of the following terms.

   a. ecosystem
   b. solar radiation
   c. photosynthesis
   d. cellular respiration
   e. producers
   f. herbivores
   g. carnivores

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☑ D. Analysing
- ☑ E. Synthesizing
- ☐ F. Evaluating

2. Copy and complete the concept map that follows using arrows to indicate the directional flow of energy. On each arrow write the name of the process that transfers energy from one population to another.



Check your answers by turning to the Appendix, Section 1: Activity 2.

food chain – the flow of chemical energy from one organism to another as they feed on one another

trophic level – a feeding level or role that a group of organisms perform within an ecosystem

decomposers – those organisms that break down the organic material in dead organisms

Your concept map represents a generalized **food chain**. In this activity you will learn the role of each **trophic level** in an ecosystem. You will also learn the interactions among populations as they search out and obtain the fuel of life.

3. What is the result of an uneven distribution of solar energy throughout the biosphere?

4. How do producers capture and transform the energy from the sun?

5. List five ways the energy obtained from producers is used.

6. Why do carnivores obtain less energy from herbivores than herbivores obtain from producers?

7. Explain the important role of **decomposers** in food chains.

Check your answers by turning to the Appendix, Section 1: Activity 2.

An example from a prairie ecosystem may help you understand the interactions among the organisms in a simple food chain.

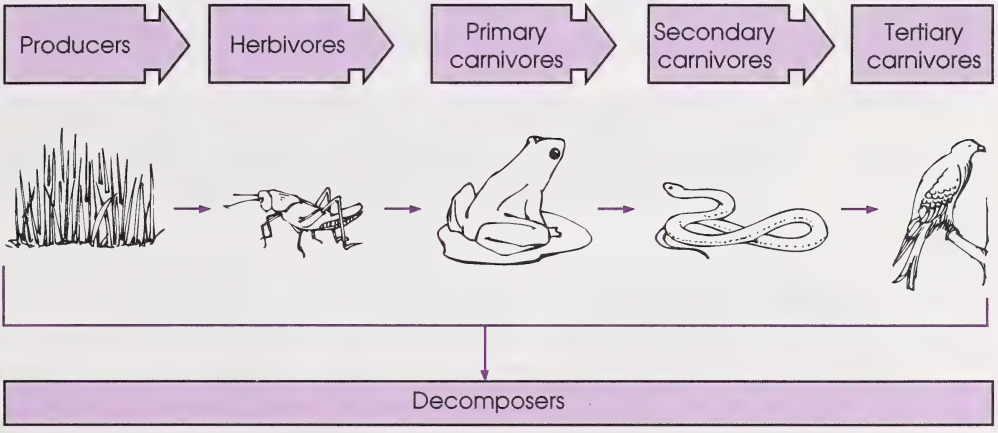


FIGURE 3.3 A Food Chain

The food chain shown in Figure 3.3 has three trophic levels: producer, consumer, and decomposer. Decomposers are busy at all levels of the food chain. The consumer level is divided into four sublevels: herbivore, primary (first-order) carnivore, secondary (second-order) carnivore, and tertiary (highest-order) carnivore.

Use Figure 3.3 to answer the next four questions.

8. Which trophic level does the frog occupy?

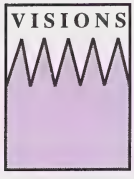
9. Why is the hawk considered to be the top carnivore?

10. If all the grasshoppers in this ecosystem died, what would happen to the food chain?

drought – a period without rain which makes an area dry

11. Which trophic level would decrease the most if there were a **drought**?

Check your answers by turning to the Appendix, Section 1: Activity 2.



Next you will discover that trophic levels can be described in terms of food webs and food pyramids. Read Trophic Levels Can Be Described in Terms of Pyramids of Energy, Numbers, and **Biomass** on pages 121 and 122 of *Visions 2*. After you finish reading, answer the following questions.

12. Which trophic level stores the greatest amount of chemical energy?

biomass – the dry weight of an organism which is able to store energy

13. Which trophic level stores the least amount of chemical energy?

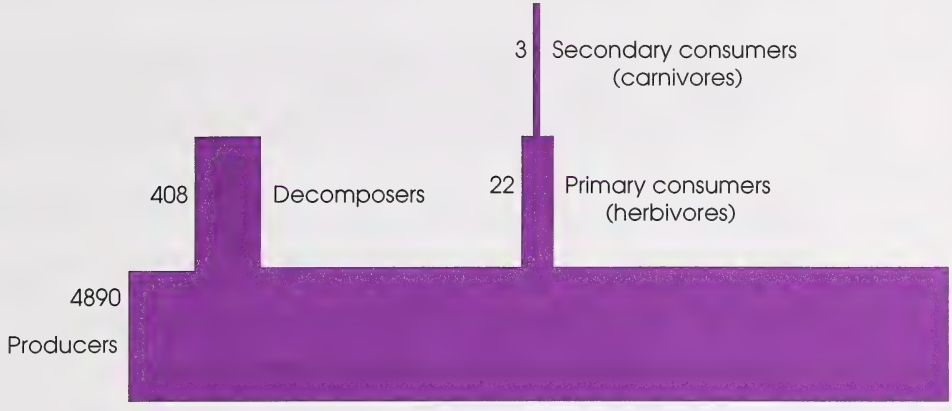
14. Why is **harvesting** less than 100% efficient?

Check your answers by turning to the Appendix, Section 1: Activity 2.

harvesting – the processes involved in transferring chemical energy from one trophic level to another

The study of ecosystems usually begins by identifying the trophic levels occupied by each population. Ecologists can count the organisms, find their mass, and measure their roles in the energy flow and the cycling of matter. Overall estimates of energy, numbers, and biomass are made and the results for all the populations at the same trophic level are then added together to produce a pyramid. In the diagrams that follow, the various trophic levels are represented as a series of steps of the same height, but differing width. The width is proportional to the energy, numbers, or biomass of all the organisms at a particular trophic level in the pyramid.

Pyramid of Energy Flow for the Arctic Tundra Ecosystem (KJ/m²/a)

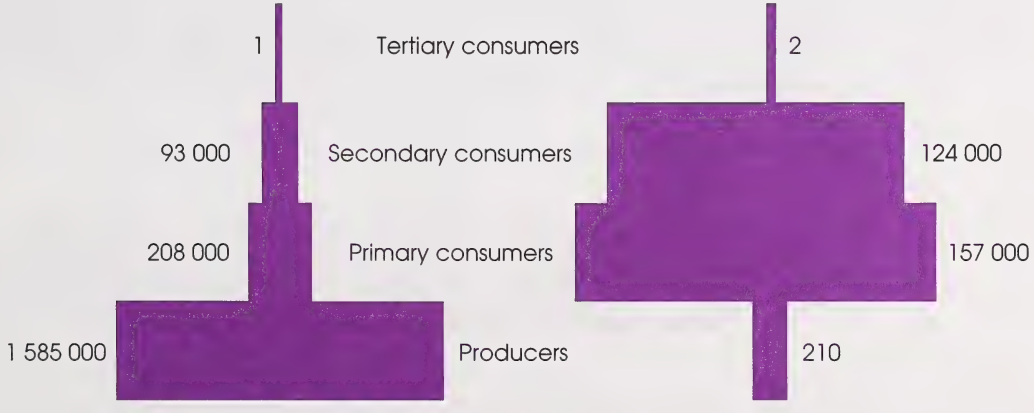


15. Why is the pyramid of energy flow for an ecosystem always pyramidal in shape?

16. Should the energy eaten by the organisms or the energy stored by the organisms be used to construct the pyramid? What is the difference?

Check your answers by turning to the Appendix, Section 1: Activity 2.

Pyramids of the Number of Organisms for Grassland and Temperate Forest Ecosystems



Grassland Ecosystem (Summer) **Temprate Forest (Summer)**

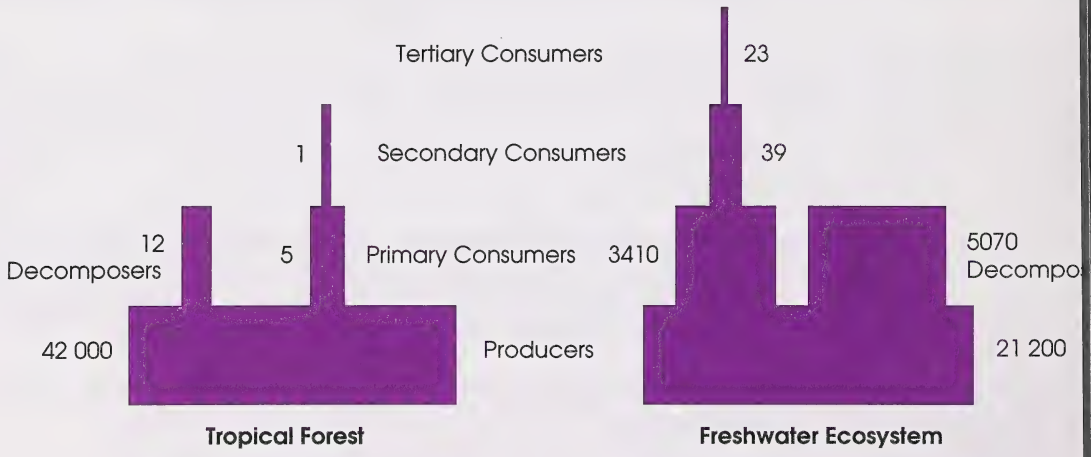
17. Why are pyramids of number of organisms not always a valid way to compare ecosystems?

18. How might each of the pyramids of number of organisms in the graphic differ at different times of the year?

Check your answers by turning to the Appendix, Section 1: Activity 2.

The pyramid of numbers is not often used by ecologists because it treats the individuals of all species as though they are identical. For example, a tree, a rabbit, and an ant each count as one unit. A whale would also count the same as one bacterium! Obviously, the pyramid ignores size. To the hungry fox, size is very important. A rabbit makes a better meal than a mouse! Therefore, a pyramid of biomass is more useful to an ecologist.

Pyramids of Biomass in Tropical Forest and Freshwater Ecosystems (kg)



19. If the mass of herbivores in each ecosystem is more than five times that of the producers which support them, how can they survive over a long time at these biomasses?

20. There is a major problem when using pyramids of biomass to study ecosystems. What is it?

Check your answers by turning to the Appendix, Section 1: Activity 2.

Now you are ready to use what you have learned and investigate a typical Alberta prairie food chain. Remember what all food chains have in common; they capture solar energy, store it as chemical energy, transfer it from one trophic level to another, and lose it as heat into the atmosphere.

Science Skills

- ☐ A. Initiating
- ☑ B. Collecting
- ☑ C. Organizing
- ☑ D. Analysing
- ☑ E. Synthesizing
- ☑ F. Evaluating

Investigation: Energy Intake in a Food Chain

Follow the directions of this investigation carefully. Pay special attention to the required components and applied science skills.

Purpose

Study the relationship between energy intake and trophic level.

Materials

- paper and pencil
- calculator

Procedure

VISIONS

Follow Steps 1 to 5 on page 123 of your textbook. Make a chart similar to the one provided in the Observations section of this investigation.

Observations

21. Calculations for Steps 1 to 4 can be recorded in your chart, and Step 5 should be answered as indicated.

Organism	Daily Energy Requirement (kJ)	Yearly Energy Requirement (kJ)	Energy Provided by Previous Trophic Level (kJ)	No. of Organisms from Prev. Trophic Level Required to Feed One Organism for 1 Year	Total Population	Energy Stored at Each Trophic Level (kJ)
hawk	330		400 (per weasel)		1	4000
weasel	80		100 (per mouse)			
mouse	20		12 (per wheat plant)			
wheat plant	5.5		—	—		

Assistance for calculations:

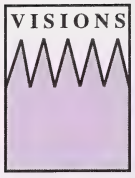
Step 1: Yearly energy requirement = daily energy requirement × 365

Step 2: $$\text{Number of organisms from previous trophic level required to feed one organism for one year} = \frac{\text{yearly energy requirement}}{\text{energy provided by previous trophic level}}$$

Step 3: $$\text{Total population} = \left(\frac{\text{number of organisms required to feed one organism at the next higher trophic level} \times 100}{\text{\% eaten by next higher trophic level}} \right) \times \text{number of organisms at the next higher trophic level}$$

Step 4: $$\text{Energy stored at each trophic level} = \text{energy stored in tissues} \times \text{total population}$$

22. Calculate the area required to support a hawk for one year.



23. Complete questions 1, 2, and 3 from the Observation section on page 124 of *Visions 2*.

Analysis and Interpretation

24. Complete questions 1, 2, 3, and 5 from the Analysis and Interpretation section on page 124 of *Visions 2*.

Check your answers by turning to the Appendix, Section 1: Activity 2.

It should now be clear that chemical energy is stored within the cells of living organisms. As an animal eats a plant or another animal, the stored energy is transferred. Not all the energy taken in by an organism is stored in its tissues. Most of it is used during the activities of life and some of it is lost as thermal energy.

In the final activity of this section you will study the impact that humans have had on these food pyramids. While the effect of human intervention in the natural processes of an ecosystem is generally beneficial, sometimes there are disastrous consequences.

Activity 3: Human Impact on Trophic Levels

How often have you tried to help only to have things go wrong? Have you felt hurt because you were only trying to help? After all, your intentions were good. How did you know that the result would not be what you expected? Sometimes it is hard to know whether to help or just to wait. If you wait and find out that your assistance could have saved a life or prevented a serious accident, you may get angry at yourself for not trying. How do you know what to do?

VISIONS

One of the main ways that humans affect ecosystems is through the use of **pesticides** and **herbicides**. While the intent may be good, the results may be terrible! To learn more about these effects, read the section entitled Biological Magnification on pages 125 to 127 in your textbook. After you have finished reading, answer the following questions.

pesticides – chemicals that are used to kill animals that are not wanted in a certain area

herbicides – chemicals that are used to kill plants that are not wanted in a certain area

1. In your own words, define the term *biological magnification*.
2. Which trophic level is most susceptible to biological magnification?
3. Give three examples of how chemicals affect pyramids.

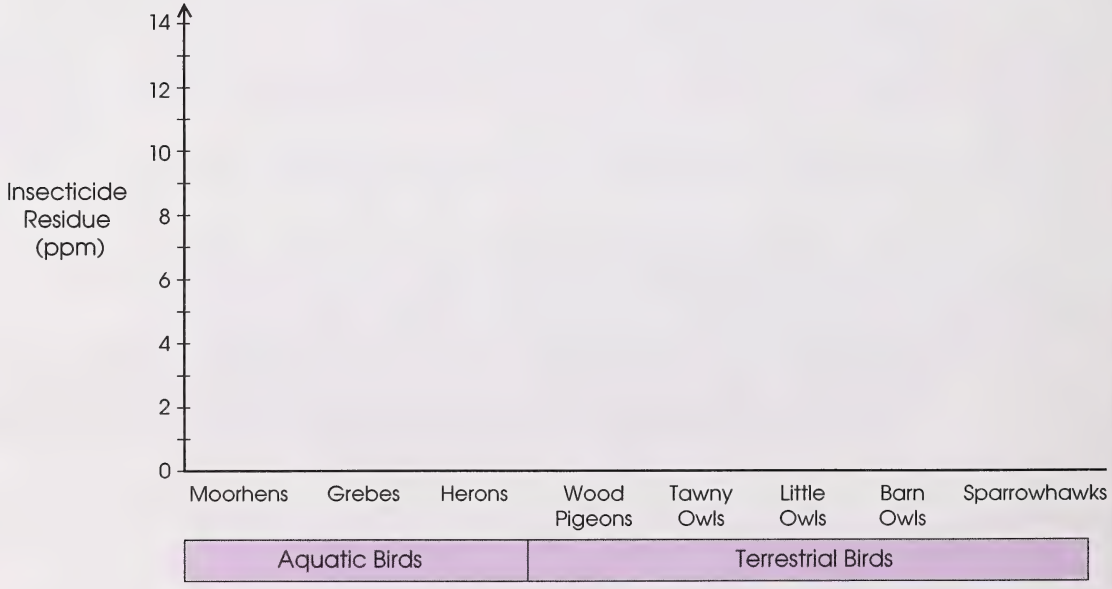
Check your answers by turning to the Appendix, Section 1: Activity 3.

There is abundant evidence that some pesticides get into the food chains, killing animals outright or affecting their reproductive success. Such pesticides include the organic insecticides like DDT. The data in Table 3.1 can be used to illustrate the effects on terrestrial and aquatic birds.

TABLE 3.1 AVERAGE CONCENTRATIONS OF DDT FOUND IN THE BREAST MUSCLE OF BIRDS IN PARTS PER MILLION (ppm)

Habitat	Type of Bird	Insecticide Residue (ppm)
aquatic	moorhens	0.3
aquatic	grebes	6.4
aquatic	herons	13.6
terrestrial	wood pigeons	0.7
terrestrial	tawny owls	1.2
terrestrial	little owls	2.0
terrestrial	barn owls	3.2
terrestrial	sparrowhawks	4.1

4. Draw a bar graph to help interpret Table 3.1. Set up your graph in the following way. Establish an appropriate scale for the amount of insecticide.



5. Explain why the moorhens and the wood pigeons have the lowest concentration of DDT in their muscles.

6. If the herons and the sparrowhawks were herbivores, how would the residue of DDT in their muscles differ from what is shown?

7. Which habitat shows greater biological magnification? Explain the significance of this for the birds in that habitat.

Check your answers by turning to the Appendix, Section 1: Activity 3.

The use of DDT has been banned in Alberta, but every new pesticide presents a potential hazard to the ecosystem until its effects are clearly known. Herbicides also take their toll. In removing weeds from agricultural land, farmers may upset the balance of nature by depriving animals of their natural habitats or removing essential links in food chains.

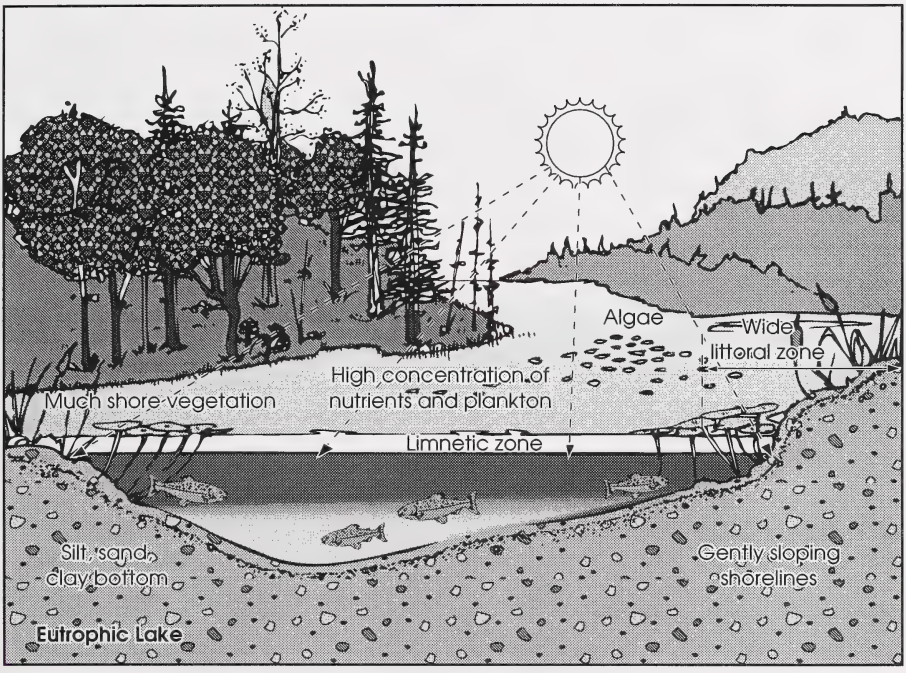


FIGURE 3.4 Eutrophication of a Lake

biodegradable pollution – waste material that can be broken down by the actions of decomposers

organic matter – carbon compounds that are found in living organisms

Another example of the impact of humans on ecosystems is **biodegradable pollution**. Sewage is rich in **organic matter** and nitrogen compounds. In small amounts, sewage can be used as an excellent fertilizer. If it is allowed to accumulate in lakes and rivers as shown in Figure 3.4, the water becomes greatly enriched in nutrients. Decomposing the extra organic matter deprives the water of its oxygen supply. In this way, the decomposers actually rob other organisms of oxygen and cause them to die.

8. If there are more nutrients available in the lake, what is the effect on the pyramid of number of organisms?

9. How will this change in numbers affect the activity of decomposers?

10. What effect does this change in activity have on the oxygen levels in the lake?

11. If aquatic animals, including decomposers, deplete the oxygen in the water, ultimately what will happen as a result of an increase in sewage in the lake?

Check your answers by turning to the Appendix, Section 1: Activity 3.

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

In this section you have learned that there is an organization that exists within the biosphere. Energy is required at each trophic level, and each level is dependent upon the next for its energy.

1. Use the following terms to create a flow chart that begins with the simplest level and progresses toward the most complex level.

• biosphere	• cell	• community
• ecosystem	• organ	• organ system
• organism	• population	• tissue

2. What, besides energy, do organisms at each trophic level require from the organisms they feed on?

3. What balance must exist within a healthy ecosystem?

You also traced the flow of energy through the biosphere. Go back and examine the photograph at the beginning of Section 1. Imagine yourself hang gliding or doing one of the activities mentioned in the introductory paragraph of Section 1.

4. Where would you get the energy to maneuver the car while racing or to stay in the kite while hang gliding?

5. Would you obtain more of the original energy entering the food chain by eating bacon and eggs or the same mass of oatmeal? Why is there a difference in the amount of energy stored in these different kinds of food?

6. How does the producer store the radiant energy of the sun?

7. Ultimately, where does the energy to perform all human activity come from?

8. Using a flow chart, diagram a four-level food chain that includes you as the top consumer.

Check your answers by turning to the Appendix, Section 1: Extra Help.

Since many organisms at each feeding level interact with each other, food webs exist. These webs can be viewed collectively within an ecosystem to produce pyramids.

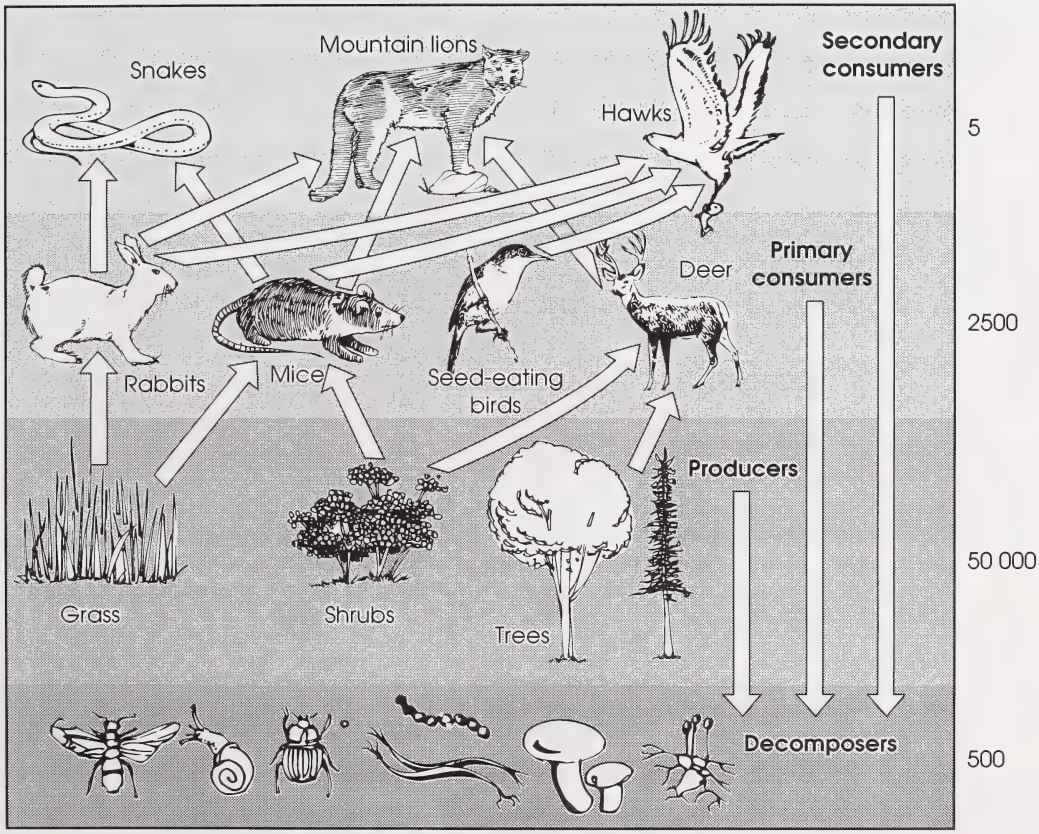


FIGURE 3.5 A Simplified Food Web

Use Figure 3.5 to answer the next three questions. Note that the numbers to the right of the figure represent the relative number of organisms.

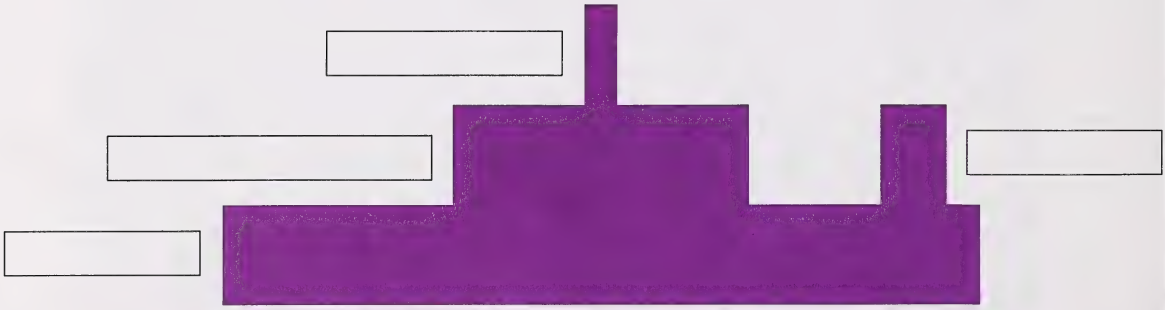
9. What are the three major trophic levels?

10. Make a chart similar to the one that follows. Then complete the chart with appropriate examples for two distinct food chains within the food web.

Trophic Levels	Food Chain 1	Food Chain 2
producers		
herbivores		
decomposers		

11. What is the importance of each trophic level?

12. Make a pyramid of numbers similar to the one that follows. Give the correct name for each level of the pyramid of numbers shown.



13. If a hazardous chemical is introduced into the food web, in which level of the pyramid would you expect to find the greatest biological magnification? Explain your answer.

Check your answers by turning to the Appendix, Section 1: Extra Help.

Enrichment

1. Visit a local supermarket and list ten foods for each category in the Canada Food Guide. Determine the origin of each of these foods and determine which foods will provide the best energy value for you as the top consumer.

2. How could you improve the energy efficiency of your diet without changing the amount of biomass you eat? Give specific examples to illustrate your answer.

VISIONS

3. Design a food chain and a food web using organisms found in your local area. Research the organisms you find and use the information found in Table 4.2 on page 120 of your textbook to predict possible pyramids of energy, numbers, and biomass.

4. Trace the route of a grain of wheat from the planting of the seed to its preparation in a loaf of bread you eat at home. Include the role of energy inputs and outputs along the route. What effect might chemicals like pesticides and herbicides have on you?

Check your answers by turning to the Appendix, Section 1: Enrichment.

Conclusion

In this section you have learned that solar energy fuels the biosphere. Producers transform the radiant energy of the sun into chemical energy and store some of it in their tissues. Consumers get their energy from producers, but there is a progressive loss of energy from one trophic level to another. The natural balance in nature can be destroyed by humans.

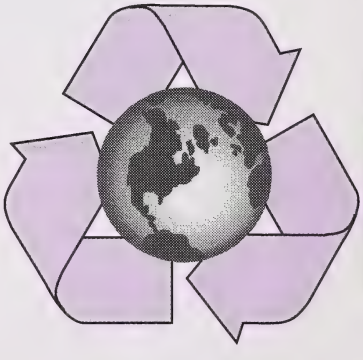
ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 1.

Section

2 Matter Cycles Within the Biosphere

Have you ever noticed how much of your life is based on circles? Time is determined by the Earth's daily circle as it rotates on its axis and its yearly circle around the sun. The sensation of speed is created by the circling of wheels, which reduces friction and maximizes force. Most games involve a circling of balls, birdies, pucks, or rings between players, over a net, into a hoop, or round and round on a pole! Life is also a circle – an endless circle of matter and energy transformations.



You have already learned that energy flows through the biosphere. In this section you will examine the essential nature of recycling the basic elements for life. This will help you understand the importance of each component in the exciting game of life.

Activity 1: The Importance of the Hydrologic Cycle

AACD

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If you were to walk across a desert or some other very dry location, you might not see any signs of life for many kilometres. Then, you suddenly see green! As you come closer, you find a few bushes and some trees. You know why the plants are there, but you probably cannot see why. Where there is life, there is water! As the preceding pictures show, where there is water, there is life and sometimes damage to organisms if the water arrives in violent storms.

VISIONS

To learn about the importance of water in the biosphere, read the section entitled The Hydrologic Cycle on pages 127 to 129 of *Visions 2*. When you are finished reading, answer the following questions.

1. What form of energy drives the hydrologic cycle?

2. There are four processes that cycle water in the biosphere. Which two processes are abiotic and which two are performed by living organisms?

3. How long will water remain in the atmosphere before it returns to the Earth as precipitation?

Check your answers by turning to the Appendix, Section 2: Activity 1.

PATHWAYS

If you have access to the video entitled *Water: A Precious Resource* do Part A. If you do not, then do Part B.

Part A

Familiarize yourself with the following questions and then view the National Geographic video entitled *Water: A Precious Resource*. As you view the video, answer the questions. Pause the tape whenever necessary to write your responses.

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☑ D. Analysing
- ☑ E. Synthesizing
- ☑ F. Evaluating

4. How much water on the Earth is found in the oceans, glaciers, and polar ice caps?

5. List four examples of water vapour condensing in the air.

6. Most major cities border rivers. What roles does water play that are essential to the activities of humans?

7. Describe the functions of groundwater that benefit humans.

8. Explain the importance of the two-step process for sewage treatment described at the end of the video.

Check your answers by turning to the Appendix, Section 2: Activity 1.

End of Part A

Part B

9. Using any references that are available to you in your home or a nearby library, research water as a vital human resource. Answer questions 4 to 8 in Part A.

Check your answers by turning to the Appendix, Section 2: Activity 1.

End of Part B

Science Skills

- ☐ A. Initiating
- ☑ B. Collecting
- ☑ C. Organizing
- ☑ D. Analysing
- ☑ E. Synthesizing
- ☑ F. Evaluating

Investigation: Measuring Rates of Precipitation and Evaporation

Follow the directions of this investigation carefully. Pay special attention to the required components, safety aspects, and applied science skills.

Purpose

Find the rates of precipitation and evaporation in your area.

Materials

- four flat-bottomed containers such as ice cream pails, tin cans, glasses, and so on

  Note: If you are using cans, you will have to devise a method of measuring the depth of water in the can. If you are using glasses, be sure that the bottoms of the inside of the glasses are flat.

- ruler

Procedure

- Follow the procedure in your textbook on pages 129 and 130. Make a chart similar to the one in the Observations section of this investigation. Collect your data and record it in your chart.

- You may need to extend the time for data collection during times of low precipitation.

- If you are performing this investigation when precipitation is in the form of snow, take your container indoors after collection to melt the snow. Cover the container to ensure there is little or no evaporation while the snow is melting.

- In the case of evaporation in cold weather (below 0° C), you will have to observe the evaporation indoors. Consider this when you are writing your report and answering the questions.

- To set up a control for the rate of precipitation, simply place a container of the same size as the one for collecting precipitation in a location where it cannot receive precipitation.

- To set up a control for the rate of evaporation, use a sealed container of the same size with a given level of water in it. Mark this level.

Observations

10. Record your data in your chart.

Container	Precipitation or Evaporation (mm/d)						
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
container for collecting precipitation							
container for precipitation control							
container for evaporation							
container for evaporation control							

VISIONS

Analysis and Interpretation

11. Complete questions 1, 2, 3, 4, and 5 from the Analysis and Interpretation section on pages 130 and 131 of *Visions 2*. (If you are not a classroom student, omit question 2.)

Check your answers by turning to the Appendix, Section 2: Activity 1.

VISIONS

To learn more about the hydrologic cycle, read pages 131 to 133 of *Visions 2*. When you are finished reading, answer the following questions.

aquifers – water-bearing areas of sand, gravel, or permeable rock that lie above impermeable rock

12. How long does water remain on land?

13. What two events occur to runoff water that make it available to living organisms?

14. Why are **aquifers** important to human beings?

potable water – water that is suitable for human consumption

15. Why is providing **potable water** an ever-increasing problem for humans?

Check your answers by turning to the Appendix, Section 2: Activity 1.

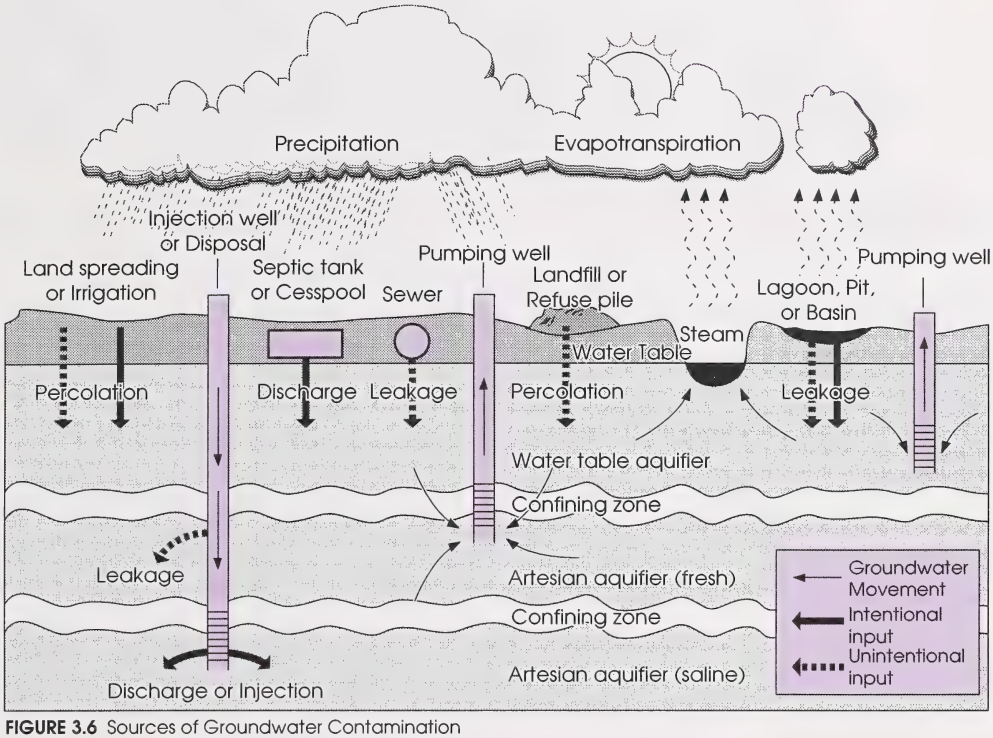


FIGURE 3.6 Sources of Groundwater Contamination

The fresh water beneath the Earth's surface is the most precious and least protected resource of the biosphere. It is a major source of drinking water for over half of the world's humans. Any **pollutant** that comes in contact with the soil may contaminate ground water.

pollutant – any chemical substance that can disrupt the health of a living organism

Examine Figure 3.6 and answer the following questions.

16. What are the three major ways that pollutants enter the water table aquifer?

17. Which aquifer is the most important for potable water? Explain your answer.

18. How can groundwater be safer from pollutants so aquifers can supply fresh water to many parts of the world?

Check your answers by turning to the Appendix, Section 2: Activity 1.

Have you ever noticed how much more you sweat on a dry, hot day? Have you ever been frustrated when getting into your car with your friends on a cold, winter day and all the windows fog up? These events give evidence that plants and animals lose water to the atmosphere. Obviously, in order to give off water, it must be consumed first! A natural balance exists between plants and animals in the biotic water cycle.

Investigation: Water Loss in Plants

Science Skills

- ☐ A. Initiating
- ☑ B. Collecting
- ☑ C. Organizing
- ☑ D. Analysing
- ☑ E. Synthesizing
- ☑ F. Evaluating

Follow the directions of this investigation carefully. Pay special attention to the required components, safety aspects, and applied science skills.

Purpose

Measure the rate of **transpiration** in a plant under different conditions.

transpiration – the process by which plants lose water from their leaves by evaporation

Background Information

Water loss occurs as a result of the necessity for gas exchange in plants. Transpiration also cools the leaves in much the same way that sweating cools you.

A photometer is used to measure the rate of water loss from plants. When using this device, it is assumed that the rate of water loss is the same as the rate of water uptake by the stem. In this investigation you will make and use a simple photometer.

Materials

- plant with leaves (e.g., tomato)
- test tube
- cotton ball or tissue
- cup or glass
- masking tape or adhesive tape
- 10 mL graduated cylinder
- fan (optional)
- paper
- scissors
- sharp knife
- metric ruler
- water

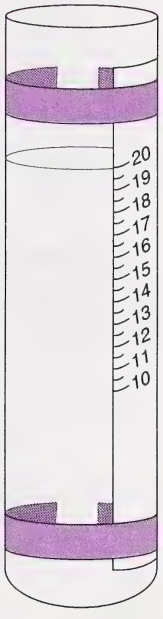
Note: You may use any plant with large leaves instead of a tomato plant. If you are doing this investigation in the winter, you may need to get a cutting from a house plant such as an African Violet. Ask an adult who has house plants for a cutting.

Procedure

Step 1: Cut a strip of paper 1 cm wide and 12 cm long. Tape the strip of paper to the side of the test tube. This strip will become a scale.

Step 2: Add 10 mL of water to the graduated cylinder. Pour the water into the test tube. Mark the level and write 10 by this mark.

Step 3: Add another 10 mL of water to the graduated cylinder. This time pour the water 1 mL at a time into the test tube and mark the level of the water each time on the paper strip. Write the numbers 11 to 20 beside the marks as you add water. You may wish to add half-millilitre marks later. You now have a calibrated test tube.



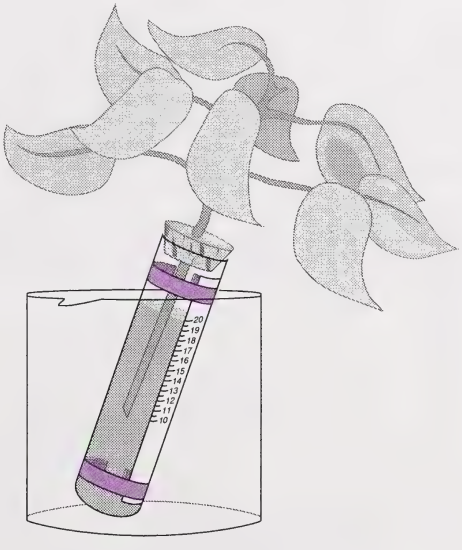
Caution

Step 4: Place the root of the plant under water in a sink or pot. Carefully cut the plant stem and insert the stem in your test tube.

Step 5: Notice the water level is now above the 20 mL mark. Carefully pour out enough water so the level is at the 20 mL mark again.

Step 6: Hold the stem in place by packing the cotton ball or tissue around the inside of the tube near the top. This will also seal the tube and slow evaporation. Do not let the cotton or tissue touch the water.

Step 7: Carefully stand the test tube in a 250 mL beaker or other suitable container so it will not tip over. Place it in a warm location.



Step 8: Make charts similar to those given in the Observations section (questions 19 and 20).

Step 9: Mark the initial level on the paper strip and take readings every ten minutes for forty minutes. (You may try every fifteen minutes for one hour if you do not get at least one or two millilitres of transpiration.) Record the test tube scale readings in the first chart in the Observations section (question 19).

Step 10: Repeat Step 9 with the plant near a fan. If you do not have access to a fan, consider testing water loss in a warm location versus a cool location.

Step 11: Complete the second chart (question 20).

Observations

19. Record your results in your chart.

Time (min)	Scale Reading (mL)		Change in Volume (mL)	
	Warm Area	Fan	Warm Area	Fan
0			0	0
10				
20				
30				
40				

20. Record your results in your chart.

Measurement	Warm Area	Fan
Total volume of water lost (mL)		
Total time elapsed (min)		
Average rate of water loss (mL/min)		

Analysis and Interpretation

21. Graph your data to compare the change in volume (dependent variable) over time (independent variable). Use graph paper or carefully draw a pair of axes with appropriate scales. Use a legend to show both conditions on the same graph.

22. What is the advantage of doing this investigation in a warm place?

23. Explain why there is a difference in the rates between the warm location and the windy location. (Compare warm and cool locations if this is what you did.)

24. List two environmental factors that might affect the rates of water loss in plants and animals. Also explain how these factors will affect water consumption.

Check your answers by turning to the Appendix, Section 2: Activity 1.

As you have learned, water is important in the cycling of many chemicals in the biosphere. The hydrologic cycle, therefore, is essential to life.

In the next activity you will learn about the other important elements in the game of life.

Activity 2: Other Biogeochemical Cycles

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Have you ever sat around a campfire, watched a candle burning, or even lit a match? Have you noticed that every eye is glued to the flames as they dance and lick the air? Humans seem to be fascinated by combustion! Maybe that explains, in part, why industrialization started with harnessing the energy from fires.

Whatever the origin, the development of machines has caused a tremendous demand for energy. The easiest and cheapest sources to be found have been fossil fuels. The impact on the carbon-oxygen cycle has been an imbalance that may threaten the future of the world as you know it.

VISIONS

To learn about these essential elements in the game of life, read about the cycling of carbon and oxygen on pages 135 to 139 of *Visions* 2. When you are finished reading, answer the following questions.

1. What is the global free oxygen supply? In what form does most of the oxygen in the biosphere exist?

2. How is carbon removed from the atmosphere and converted into biomass?

3. What role do decomposers play in the carbon cycle?

integral – essential or vital

4. What complementary biotic processes form the **integral** loop in the carbon and oxygen cycles?

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☑ C. Organizing
- ☑ D. Analysing
- ☐ E. Synthesizing
- ☐ F. Evaluating

5. Make a chart similar to the one that follows. Then complete your chart.

Processes that Increase Atmospheric O_2	Processes that Decrease Atmospheric O_2	Processes that Increase Atmospheric CO_2	Processes that Decrease Atmospheric CO_2

6. How is carbon stored in the Earth? How is oxygen stored in the Earth?

7. Explain the processes that free carbon from its stored forms, making it available to living organisms.

8. How is ozone formed and why is it important to organisms on Earth?

Check your answers by turning to the Appendix, Section 2: Activity 2.

PATHWAYS

If you have access to the video entitled *Fate of the Earth, Part 1: Geochemical Cycles,* do Part A. If you do not, then do Part B.

Part A

Familiarize yourself with the following questions and then view the video entitled *Fate of the Earth, Part 1: Geochemical Cycles* from the *Planet Earth* series. As you view the video, answer the questions. Pause the tape whenever necessary to write your responses.

9. Briefly describe the Gaia hypothesis.

10. There are four major molecules found in living organisms. What are the functions of these important building blocks for life?

11. The first forms of life have been found in Australia. What were these organisms and how did they transform the atmosphere?

12. All the cycles of matter are interconnected by the atmosphere. How long will carbon atoms stay in the air before cycling again?

Check your answers by turning to the Appendix, Section 2: Activity 2.

End of Part A

Part B

Using the information found on pages 135 to 141 of your text, answer the following questions.

13. What are biogeochemical cycles? Why are they essential to life on Earth?

14. Explain the relationship between the carbon and oxygen cycles.

15. Describe the role of hydrogen in the carbon and oxygen cycles.

16. How has human activity upset the equilibrium of the carbon cycle?

Check your answers by turning to the Appendix, Section 2: Activity 2.

End of Part B

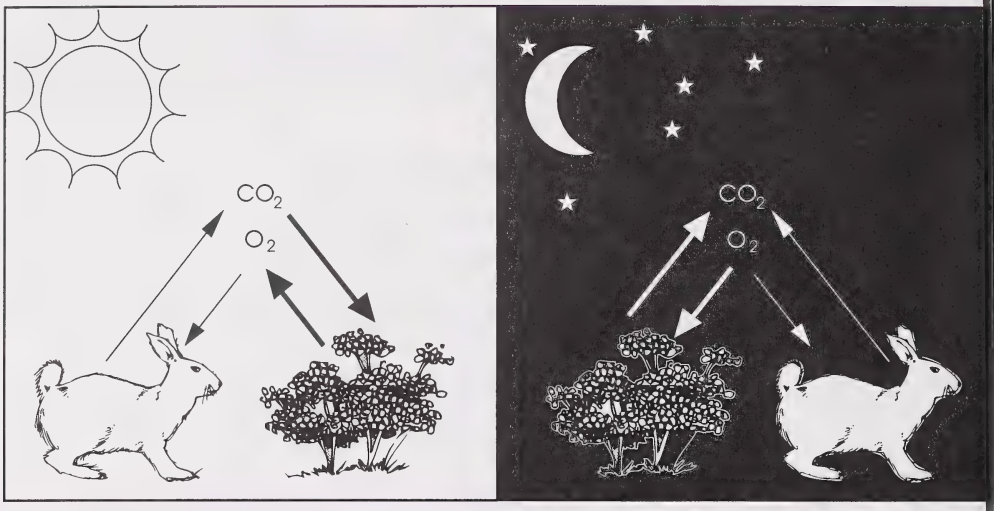


FIGURE 3.7 Day and Night Versions of Plant and Animal Activity

It is important to remember that living organisms play a vital role in the carbon-oxygen cycle. Have you thanked a plant today?

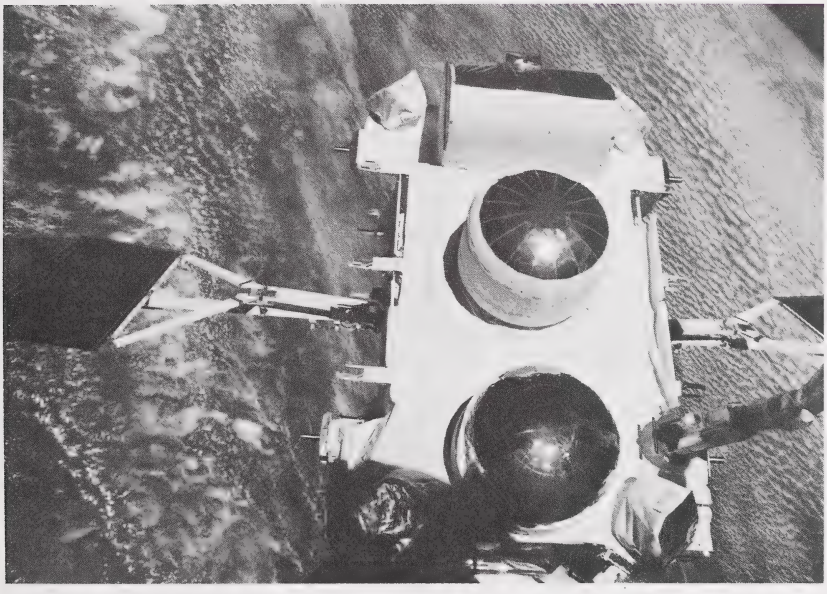
You have also read that photosynthesis occurs in light, taking CO_2 out of the air and returning O_2 to it. Cellular respiration occurs all the time in plants and animals and puts CO_2 back into the atmosphere. See Figure 3.7.

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☑ D. Analysing
- ☑ E. Synthesizing
- ☐ F. Evaluating

The following exercise will help you understand the relationship between the production of CO_2 and O_2 in plants and animals.

Suppose a space station orbiting the Earth enjoys 20 h of daylight and 4 h of darkness. In its greenhouse the plants provide the oxygen supply for the astronauts. Each gram of plant produces 10 mL of O_2 during every hour of light and consumes 5 mL of O_2 during every hour of darkness. Each gram of astronaut in the space station utilizes 5 mL of O_2 during every hour of the day.



NASA

If the carbon-oxygen cycle is perfectly balanced, the astronauts can be supported by 1000 kg of greenhouse plants. Using this information, answer the following questions to determine the number of astronauts that could be supported in this space station.

17. Calculate the amount (mL) of CO_2 produced in one day by the plants and the astronauts. (Hint: During photosynthesis, O_2 production equals CO_2 consumption.)

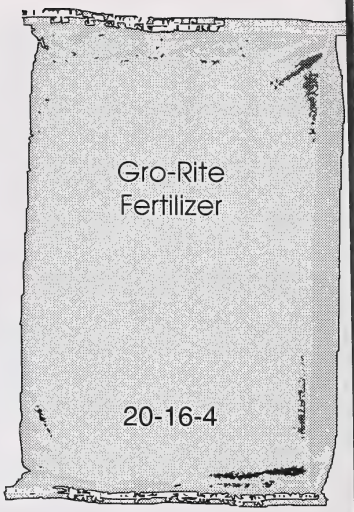
18. How much CO_2 is produced by the plants during the four hours of darkness?

19. Assuming a balance of gases is maintained, determine the number of astronauts that could be supported, assuming each astronaut has a mass of 75 kg.

Check your answers by turning to the Appendix, Section 2: Activity 2.

As you can see, the carbon-oxygen cycle is crucial to life as we know it. Another important biogeochemical cycle is the nitrogen cycle.

What do the numbers on the fertilizer bag mean? How is 20-16-4 different from 15-0-10? Whether you put too little or too much fertilizer on your lawn, you get the same yellow-looking grass! So why is fertilizer important?



VISIONS

The answer is nitrogen. This essential element is found in the form of nitrates in the fertilizer. To learn about the nitrogen cycle, read pages 141 to 144 of *Visions* 2. When you are finished reading, answer the following questions.

20. What is a nitrate?

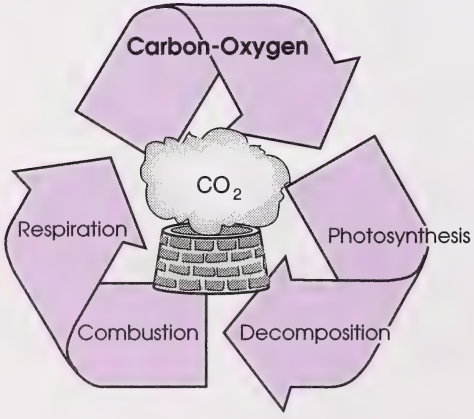
21. Describe the abiotic and biotic processes that convert atmospheric nitrogen into nitrates.

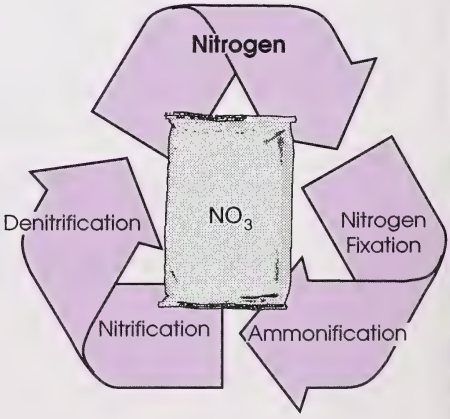
22. How do you think denitrifying bacteria might affect your lawn?

23. Why is it a good idea to plant legumes in your garden each year?

24. How have humans influenced the nitrogen cycle in a positive way?

Check your answers by turning to the Appendix, Section 2: Activity 2.





You have learned that life plays a central role in the shaping of this planet. The atmosphere is maintained by living organisms working together. Everything seems to work out just right to keep a balance in nature.

You will now learn more about the impact of humans on the biogeochemical cycles that serves to make this planet a better or worse place for all living organisms.

Activity 3: Human Impact on the Biogeochemical Cycles

Have you ever tried walking along the top of a fence? Maybe you have had to inch your way along a narrow ledge while hiking in the mountains! Have you ever gone surfing, snowboarding, or skateboarding? All of these activities require precise movements and lots of practice. If you make a mistake, then you fall. If you fall, then you simply get up and try again (except in the mountains!). Of course, it would be easier on your body if you always maintained your balance.

Since human activities cause falls in the biosphere, human activities must also help the Earth to get up and try again. After all, the Earth's future is also your future!

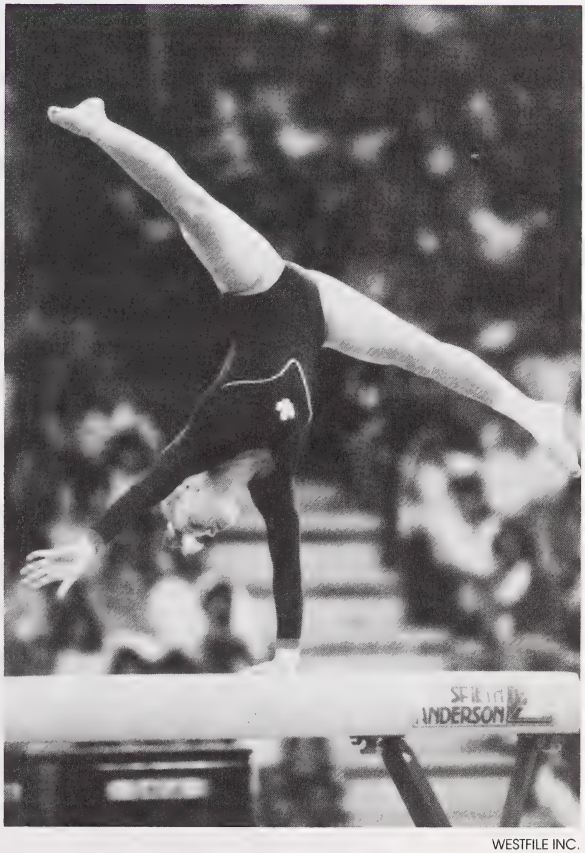


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FIGURE 3.8 Human Waste Management PHOTO SEARCH LTD.

VISIONS

The importance of reusing raw materials can help eliminate what you see in Figure 3.8. To learn more about recycling, read the section entitled Careers in Recycling on page 140 of your textbook. When you have finished reading, answer the following questions.

1. What are some techniques of recycling used in pre-industrial societies?

2. Some researchers estimate that only 15% of waste materials is being recycled. Make a chart similar to the one that follows. Complete your chart with personal examples of items that could be recycled.

Items at Home	Items at School

3. How are recycling programs in your community similar to the biogeochemical cycles you studied in Activity 2?

Check your answers by turning to the Appendix, Section 2: Activity 3.

Familiarize yourself with the following questions and then view the National Geographic video entitled, *Recycling: The Endless Circle*. As you view the video, answer the questions. Pause the tape whenever necessary to write your responses.

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☑ D. Analysing
- ☑ E. Synthesizing
- ☑ F. Evaluating

4. Summarize the three-step process by which humans produce garbage.
5. What is wrong with this process?
6. Why is garbage burned at the Babylon Resource Recovery Facility near New York?
7. Describe how aluminum cans are recycled.
8. What is the price to pay if the amount of garbage is not reduced?

Check your answers by turning to the Appendix, Section 2: Activity 3.

Investigation: Performing a Risk-Benefit Analysis

Science Skills

- ☐ A. Initiating
- ☐ B. Collecting
- ☐ C. Organizing
- ☑ D. Analysing
- ☐ E. Synthesizing
- ☑ F. Evaluating

Follow the directions of this investigation carefully. Pay special attention to the required components and applied science skills.

Purpose

Assess the risks and benefits of using deep well injection for waste disposal.

Background Information

Any human activity involves some risk to life and health. Although it is possible to reduce the existing risk, it is not possible to reach absolute safety. This makes it necessary to define an acceptable level of risk, or to perform a risk-benefit analysis. This is a means of decision making. A risk can be defined as any hazard that leads to loss or injury. Risks may involve an individual, a group, or society as a whole. A benefit can be defined as anything that promotes well-being or has a positive effect. Read the section entitled Using Deep Well Injection for Waste Disposal on pages 146 and 147 of *Visions 2* . Also refer to Figure 3.6 in Activity 1 for more information.

VISIONS

Materials

- pencil
- paper
- Visions 2

Procedure

Step 1: Identify the risks and the benefits of deep well injection from your reading. Make a chart similar to the one in the Observations section. Record the risks and benefits in your chart.

Step 2: Weigh each risk and benefit as high or low and record these weightings in your chart.

Step 3: Evaluate the acceptability or desirability of continuing to perform deep well injection. Count the number of high and low risks and benefits and make a qualitative comparison.

Observations

9. Complete your chart.

Risks	Weighting	Benefits	Weighting

Analysis and Interpretation

10. Does deep well injection produce a larger number of risks or benefits? Are the risks and benefits high or low? Explain your answer.

11. How would your opinion be affected if there were no significant leakage into the freshwater aquifer?

12. Based on your risk-benefit analysis, would you support your local government's plan to drill a deep well injection project near your home? Explain your answer.

Check your answers by turning to the Appendix, Section 2: Activity 3.

If you are actively involved in the garbage disposal process in your area, you will appreciate the positive impact humans can have on the cycling of matter. If you are not yet involved, why not?

Like the gardener that uses a greenhouse to keep temperatures up during the winter, human activities are keeping global temperatures up. In Activity 2 you learned that CO_2 is produced when fossil fuels are burned. The production of this gas occurs faster than plants can remove it from the atmosphere through photosynthesis.

VISIONS

From your reading of pages 97 to 104 in Chapter 3 of *Visions 2*, you know that the greenhouse effect has created some major problems in the biosphere.

The future of global warming is yours! Are your hands tied? What can you do? How can one person make a difference? Why bother trying?

Familiarize yourself with the following questions and then view the ACCESS Network video entitled *Global Warming: Hot Times Ahead*. As you view the video, answer the questions. Pause the tape whenever necessary to write your responses.

Science Skills

- ☑ A. Initiating
- ☐ B. Collecting
- ☑ C. Organizing
- ☑ D. Analysing
- ☑ E. Synthesizing
- ☐ F. Evaluating

13. Make a chart similar to the one that follows. Fill in both columns of your chart as you watch the video.

Activities that Increase Greenhouse Gases	Activities that Decrease Global Warming

14. Alterations in the carbon-oxygen cycle occur as a result of burning fossil fuels. Predict the effects of these alterations on the hydrologic cycle.

15. How could you test your prediction?

Check your answers by turning to the Appendix, Section 2: Activity 3.

In this activity you have discovered that human activity can have devastating effects on the biosphere. It is also evident that there is much to be done to clean up this planet. By understanding the problems better, you can have a positive impact on the conditions in your area. Go on – get out and make a difference! Recycle, conserve, and make good decisions about energy, matter, and balance.

In the next section you will learn more about ecosystems and the relationships that exist between the biotic and abiotic factors. Humans perform many positive activities that contribute to the natural balance that should exist in the biosphere.

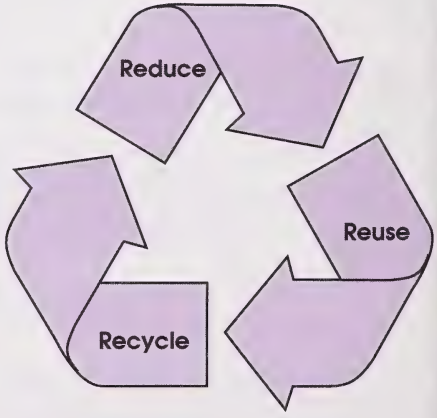
Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

In this section you have studied that the important elements for life must be recycled or else humans face some serious problems. If there are disruptions, then the game of life will become unbalanced and may even stop!

The biogeochemical cycling of matter is influenced by humans. To make certain that the water, carbon-oxygen, and nitrogen cycles remain balanced, humans must follow a three-step process as illustrated in the diagram.



1. How can these three steps (reduce, reuse, and recycle) help maintain the balance of the biogeochemical cycles?

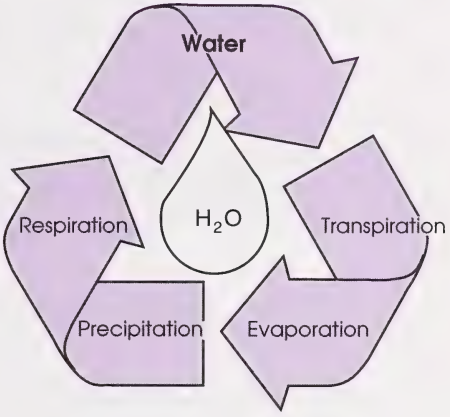
2. List three places you have seen this symbol.

Check your answers by turning to the Appendix, Section 2: Extra Help.

The Hydrologic Cycle

pecific heat – ne capacity of a ubstance to hange its emperature vhen heat is pplied

How important is water in the biosphere? Can you imagine the Earth without water? Every living organism is primarily water! The **specific heat** of water enables it to maintain a fairly constant temperature. Water is found primarily in liquid form on the Earth. The hydrologic cycle also involves transpiration from plants and respiration from plants and animals. This is illustrated in the diagram.



VISIONS

Reread the section entitled The Hydrologic Cycle on pages 127 to 133 of your textbook.

3. What are two major processes that cycle water on the Earth?

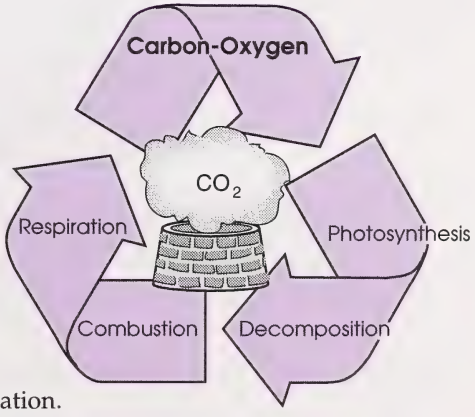
4. Explain the relationship between runoff water, capillary water, and gravitational water.

5. Describe the effects of urbanization, agriculture, recreational activities, and weather on the quality of water for human use.

Check your answers by turning to the Appendix, Section 2: Extra Help.

The Carbon-Oxygen Cycle

The carbon-oxygen cycle is very closely tied to plant photosynthesis and animal respiration. The diagram illustrates the processes of the carbon-oxygen cycle.



VISIONS

From your reading in the section entitled Biogeochemical Cycles on pages 135 to 139 of your textbook, answer the following questions.

6. Write the chemical formula for photosynthesis.

7. Where does the CO_2 come from?

8. Write the chemical formula for cellular respiration.

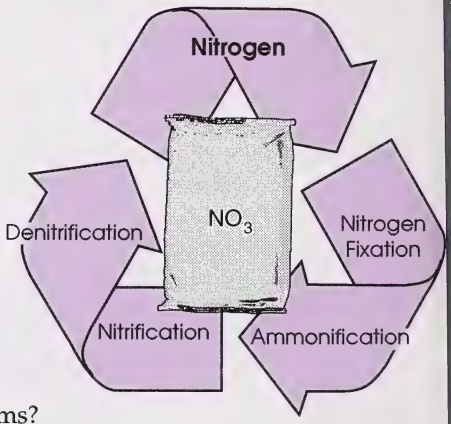
9. Where does the CO_2 go?

10. The decomposition of organic material and the combustion of fossil fuels add CO_2 to the atmosphere at an increasing rate. What effect does this have on the carbon-oxygen cycle?

Check your answers by turning to the Appendix, Section 2: Extra Help.

The Nitrogen Cycle

The role of plants in these cycles is critical. Nitrates in the soil easily dissolve in water. As water is absorbed by the roots, these nutrients are incorporated as proteins and nucleic acids in the plant. The nitrogen cycle is illustrated in the diagram.



VISIONS

From your reading about the nitrogen cycle on pages 141 to 144 of *Visions 2*, answer the following questions.

11. What role is accomplished by ammonification and nitrification bacteria?

12. Why are nitrates important to living organisms?

13. How have humans influenced the nitrogen cycle?

Check your answers by turning to the Appendix, Section 2: Extra Help.

Enrichment

1. Learn about the solid waste management program in your community by visiting your local sanitation, public works, or environmental resource authority.

2. Set up a rain gauge in an open area near where you live to monitor precipitation. Monitor relative humidity using a home-made hygrometer. Take readings twice a day, in the morning (8:00 a.m.) and the evening (6:00 p.m.) Compare your results to those from the local weather office and see how precipitation is distributed throughout the year in your community. This research should help you understand how the water cycle affects life in your community.

3. Find out from a local hospital or physician how to measure human water balance. What practical value does this knowledge have in your daily use of water?

4. Research the problems encountered in the biosphere when fossil fuels are the primary source of energy in a community.

5. Design an experiment to test the effect of chemical fertilizers on the growth of plants and animals. Use fertilizers with different **NPK** numbers to determine what each nutrient will do.

NPK – a representation of the nitrogen, phosphorous, and potassium content of fertilizers

Check your answers by turning to the Appendix, Section 2: Enrichment.

Conclusion

In this section you have discovered that the game of life is played best when water, carbon, oxygen, and nitrogen are cycled in the most natural way. Human activities may alter these cycles, but they must not alter the cycles so much as to cause a great imbalance and disruption.

ASSIGNMENT

Turn to your Assignment Booklet and do the assignment for Section 2.

Section

3 A Balance in Nature

WESTFILE INC.

Have you ever wondered what your area looked like one hundred years ago? You may have seen dramatic changes in just the last five years! Maybe there is a shopping mall where a drive-in theatre once stood. Open farmland may have been replaced with houses, parks, or apartment buildings. An old school may be a museum and now you attend a new one. Humans certainly do change their surroundings!

While some alterations to the environment may be made by humans, there are many that are natural. A flood can change the course of rivers and streams and affect the fertility of a particular region. Volcanoes can devastate an area. Fortunately, new plant species usually grow and return the area to its original state. Hurricanes can cause incredible damage to human property and also upset the natural balance in the plant and animal populations of an ecosystem. Even a single beaver dam can dramatically change an area!

In this section you will learn that ecosystems are defined in terms of specific abiotic factors. As these factors change from one region to another, new ecosystems are created. There is generally a dynamic equilibrium that exists; so an area remains relatively constant. However, sometimes disaster strikes and an ecosystem has to start all over again!

Activity 1: Abiotic Factors in Ecosystems

Terrestrial ecosystems are land-based and aquatic ecosystems are water-based. The condition of the environment represents the most basic factor affecting the communities of an ecosystem. Since the environment influences the climate of an area, it can be considered as the sum total of the abiotic factors.

VISIONS

To learn about the specific conditions within terrestrial and aquatic ecosystems, read the section entitled Abiotic Factors on page 153 of your textbook. When you are finished reading, answer the following questions.

ALBERTA RECREATION AND PARKS

1. Identify four climatic factors and two physiographic factors in the preceding diagram.

2. Predict the edaphic factors that might be found in an area such as the one shown in the preceding diagram.

3. What impact will the abiotic factors have on an ecosystem?

Check your answers by turning to the Appendix, Section 3: Activity 1.

Climatic Factors Affect Ecosystems

VISIONS

Ecosystems are characterized by their abiotic factors. As you learn more about these factors, you will better understand the variety of ecosystems on the Earth. Read the section entitled Climatic Factors Include Light, Temperature, Moisture, Wind, and Fire on pages 158 to 164 of your textbook. When you are finished reading, answer the following questions.

4. How would the rate of photosynthesis in the plants of an ecosystem be affected if there were constant, daily cloud cover?

5. Explain why most aquatic plants grow near the surface of the water.

6. What is the range of temperatures that can support life?

7. How might living organisms cope with a lack of water?

8. What are some effects of wind on an ecosystem?

9. Explain the benefits of fire in an ecosystem.

Check your answers by turning to the Appendix, Section 3: Activity 1.

Physiographic Factors Affect Ecosystems

VISIONS

To continue your study of abiotic factors, read pages 164 and 165 of *Visions* 2. When you are finished reading, answer the following questions.

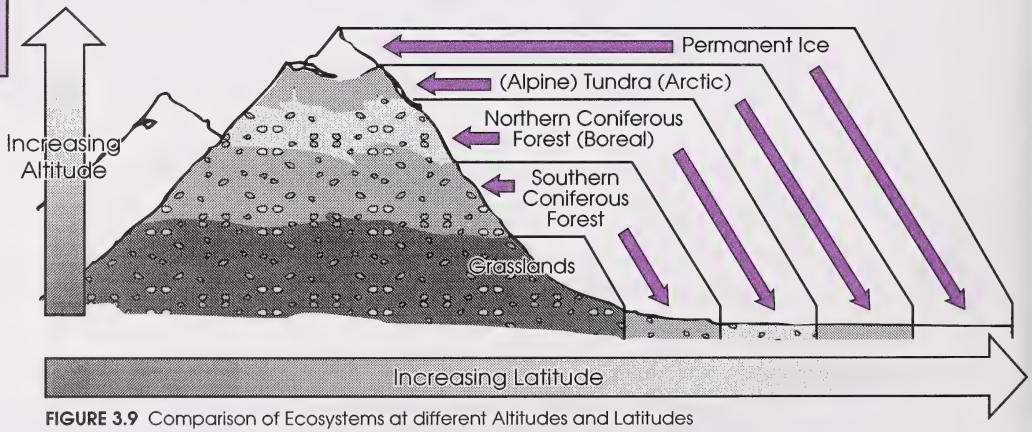


FIGURE 3.9 Comparison of Ecosystems at different Altitudes and Latitudes

10. Refer to Figure 3.9 as well as the information in the textbook to help you answer this question. Why do changes in latitude and changes in altitude produce similar changes in the diversity of species in ecosystems?

VISIONS

11. Using Figure 4.2 on page 117 and Figure 5.6 on page 164 of your textbook, predict the latitudes that might correspond to each change in altitude and subsequent change in vegetation.

12. How does the topography of an ecosystem affect its average yearly temperature and precipitation?

Check your answers by turning to the Appendix, Section 3: Activity 1.

Edaphic Factors Affect Terrestrial Ecosystems

VISIONS

To conclude your study of abiotic factors, read pages 166 and 167 of your textbook. When you have finished reading, answer the following questions.

13. What is soil?

14. How does soil form the foundation of terrestrial ecosystems?

15. Which edaphic factors will increase the fertility of the soil?

Check your answers by turning to the Appendix, Section 3: Activity 1.

Science Skills

- ☑ A. Initiating
- ☑ B. Collecting
- ☑ C. Organizing
- ☑ D. Analysing
- ☑ E. Synthesizing
- ☑ F. Evaluating

Investigation: Investigating Abiotic Factors of Aquatic or Terrestrial Ecosystems

This investigation involves a field trip. Follow the directions of this investigation carefully. Pay special attention to the required components, safety aspects, and applied science skills.

Purpose

Find the abiotic factors that influence the formation of an aquatic ecosystem or a terrestrial ecosystem.

PATHWAYS

If you are in a classroom, do Pathway A. If you are working alone on this course at home or at school, do Pathway B.

Note: If you are doing this investigation in the winter, you will be somewhat limited as to what you can do. Check your sites for animal tracks, droppings, signs of eaten vegetation, and so on. Try to do as many of the procedures as you can.

Pathway A

Background Information

Do either Part A or Part B or both.

In this investigation you will gather data from either an aquatic location, a terrestrial location, or both. Read Activity 5.1 on pages 153 to 158 of *Visions* 2.

Part A: An Aquatic Ecosystem

Materials

The materials are listed on page 154 of your textbook.

Procedure

Perform Steps 1 to 9, and 12 and 13 of Part A in Activity 5.1, which is found on pages 154 and 155 of your textbook.

Observations

16. Complete questions 1 to 4 from the Observations section in Activity 5.1 as found on pages 155 and 156 of your textbook.

Analysis and Interpretation

17. Complete questions 2, 5, 8, 14, and 16 from the Analysis and Interpretation section of Activity 5.1 found on pages 157 and 158 of your textbook.

Check your answers by turning to the Appendix, Section 3: Activity 1.

End of Part A

Part B: A Terrestrial Ecosystem

Note: This could be a location on the school grounds.

Materials

VISIONS

Use whatever materials are necessary from the list of materials on page 154 of your textbook for study of a grassy or treed area.

Procedure

Perform Steps 1 to 6 in Part B of Activity 5.1, which is found on page 156 of your textbook.

Step 7: Describe any plants, insects, and animals found in your site.

Observations

18. Complete questions 1 to 4 from the Observations section of Activity 5.1 on page 157 of your textbook.

Analysis and Interpretation

19. Complete questions 2, 9, 10, 11, 12, 14, and 16 from the Analysis and Interpretation section of Activity 5.1 on pages 157 and 158 of your textbook.

Check your answers by turning to the Appendix, Section 3: Activity 1.

End of Part B

End of Pathway A

Pathway B

VISIONS

In this part of the investigation you may study an aquatic ecosystem, a terrestrial ecosystem, or both. Read the procedure carefully before proceeding. Also read the investigation on pages 154 to 158 of your textbook. This investigation is designed for groups, but it also contains valuable information for investigations by individuals.

Caution

Proceed with caution around aquatic or terrestrial sites. If possible, have a friend or a parent go with you. Obtain permission before going onto someone else's property.

Part A: An Aquatic Ecosystem

Materials

- suitable stream, river, pond, lake, or slough
- suitable attire and equipment (i.e., rubber boots)
- pen or pencil
- measuring tape

- notepad
- capped plastic bottle with 5 m of string attached
- stopwatch or a watch with a second hand
- thermometer
- pH paper and chart
- jar with lid

Procedure

Step 1: Choose an appropriate site and measure a section about 30 m along the edge of the water.

Step 2: Observe and record the type of ground at the bottom and along the edge of the water.

Step 3: Devise a safe way to measure the depth of the water or estimate the depth at various locations. For example, you may use a weighted, marked string on the end of a fishing rod or a long pole.

Step 4: Measure the temperature just above the water.

Step 5: Take a water sample. Measure and record the pH and temperature of the water sample.

Note: If the site is a stream or river, devise a method of measuring the approximate speed of the current using the capped bottle and the watch.

Step 6: Observe and record whether the site is sunny or shaded.

Step 7: Record the date and time and whether it is sunny or cloudy at the time of your investigation.

Step 8: Estimate and record the wind's speed and direction.

Step 9: Observe and record whether the site is sheltered or in the open.

Step 10: Observe and record whether the water is calm or moving.

Step 11: Observe and record the types of living organisms you find along the edge of the water.

Step 12: Record the different types of living organisms you observe in the water.

Observations

20. Draw a labelled diagram showing the features of your site. Include observations like the date, time, directions, areas of shade or sun, locations of trees and shrubs, and so on.

21. Draw a labelled diagram of a cross section of your site, showing water depth, what you observed in and under the water, and so on.

22. In a paragraph or two, describe the area you studied in terms of all the living and non-living things you observed.

Analysis and Interpretation

VISIONS

23. Complete questions 2, 5, 8, 14, and 16 from the Analysis and Interpretation section of Activity 5.1 found on pages 157 and 158 of your textbook.

Check your answers by turning to the Appendix, Section 3: Activity 1.

End of Part A

Part B: A Terrestrial Ecosystem

Materials

- any grassy or treed area (i.e., remote part of the schoolyard, vacant lot)
- suitable attire
- notepad
- pen or pencil
- measuring tape
- thermometer
- stakes

Procedure

Step 1: Measure a site of about 20 m by 20 m and mark the corners with the stakes.

Step 2: Observe and record the type of ground in the site (without digging).

Step 3: Measure and record the temperature in the shade and in the sun if your site has both shaded and sunny areas. Face the thermometer away from the sun when measuring the temperature in the sunny area.

Step 4: Estimate and record the wind velocity. (Include both speed and direction.)

Step 5: Check and record whether the soil feels moist or dry.

Step 6: Observe and record the different types of living organisms found in your site.

Observations

24. Draw a labelled diagram showing the features of your site.

25. In a paragraph or two, describe the site you have chosen. Refer to both the living and non-living components and how they interact.

Analysis and Interpretation

VISIONS

26. Complete textbook questions 2, 9, 10, 11, 12, 14, and 16 from the Analysis and Interpretation section of Activity 5.1 on pages 157 and 158 of your textbook.

Check your answers by turning to the Appendix, Section 3: Activity 1.

End of Part B

End of Pathway B

Activity 2: The Formation of Biomes

Measuring abiotic factors in ecosystems should have helped you understand the differences that can exist in a small geographic area. Now you will learn about the impact of climate and biotic communities on large regions of the Earth. These regions are known as **biomes**. Figure 3.10 shows the average temperature and precipitation for various biomes.

biomes – large regions of the Earth with a characteristic climate and type of vegetation

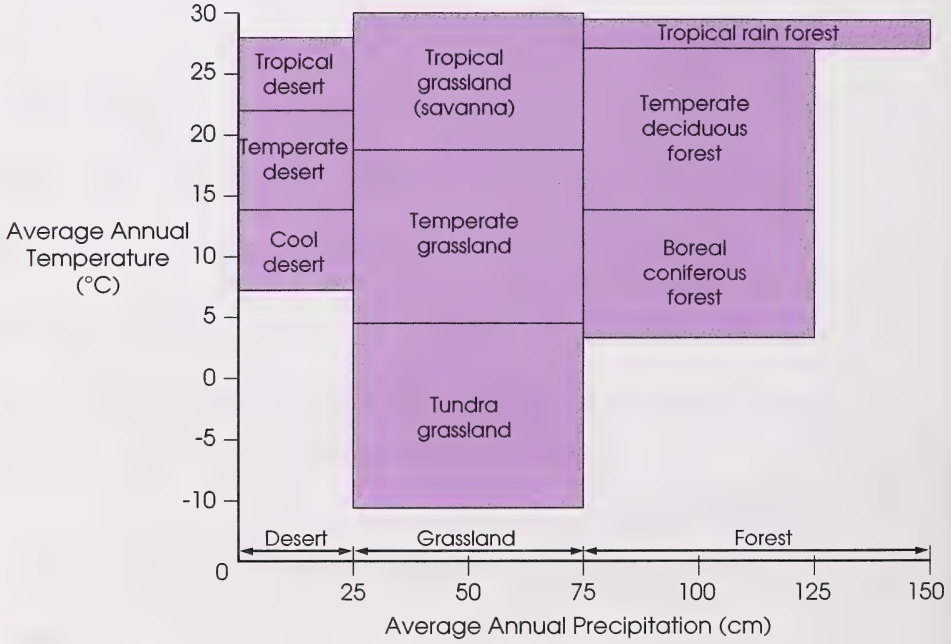


FIGURE 3.10 Desert, Grassland, and Forest Biomes of the World

VISIONS

Read the section of your textbook entitled Earth Is Divided Roughly into Biomes on pages 167 and 168. When you have finished reading, answer the following questions.

1. Why are the abiotic factors of an area known as **limiting factors**?
2. How do trophic levels influence the formation of biomes?
3. What is the most important limiting factor in a terrestrial ecosystem?
4. What is the most important limiting factor in an aquatic ecosystem?
5. Describe the changes in climate that could alter the boundary between the tundra and the rain forest, if they were found beside one another.

limiting factors – the abiotic factors of an ecosystem for which there is competition among the living organisms

Check your answers by turning to the Appendix, Section 3: Activity 2.

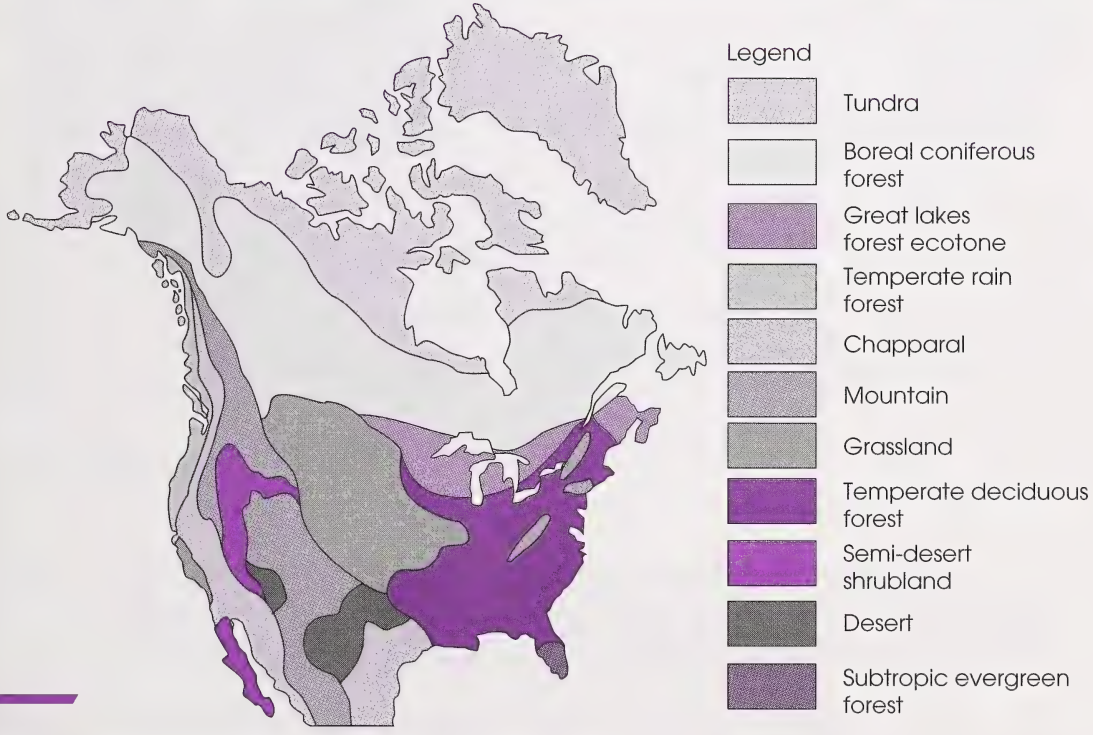


FIGURE 3.11 The Major Biomes of Canada and the United States

climax community – the dominant plant species that live in a particular area

Each biome occurs where it does because of a unique climate. Each biome also has a characteristic **climax community** because of that climate. Using Figure 3.11, answer the following questions.

6. Which biomes are found in Alberta?

7. Which biomes have you visited in Canada and the United States?

8. List three important limiting factors that have contributed to the creation of the biomes that you find in Alberta.

Check your answers by turning to the Appendix, Section 3: Activity 2.

climatogram – a graph which summarizes the variations in temperature and precipitation in a biome

Ecologists who study the distribution and adaptations of organisms in a biome need to know the past history of the climate of that biome. This history is often shown in a **climatogram**. A climatogram shows the monthly variations in temperature and precipitation during the year. Remember that climate affects the vegetation that grows in a region; therefore, it affects the location of biomes around the Earth.

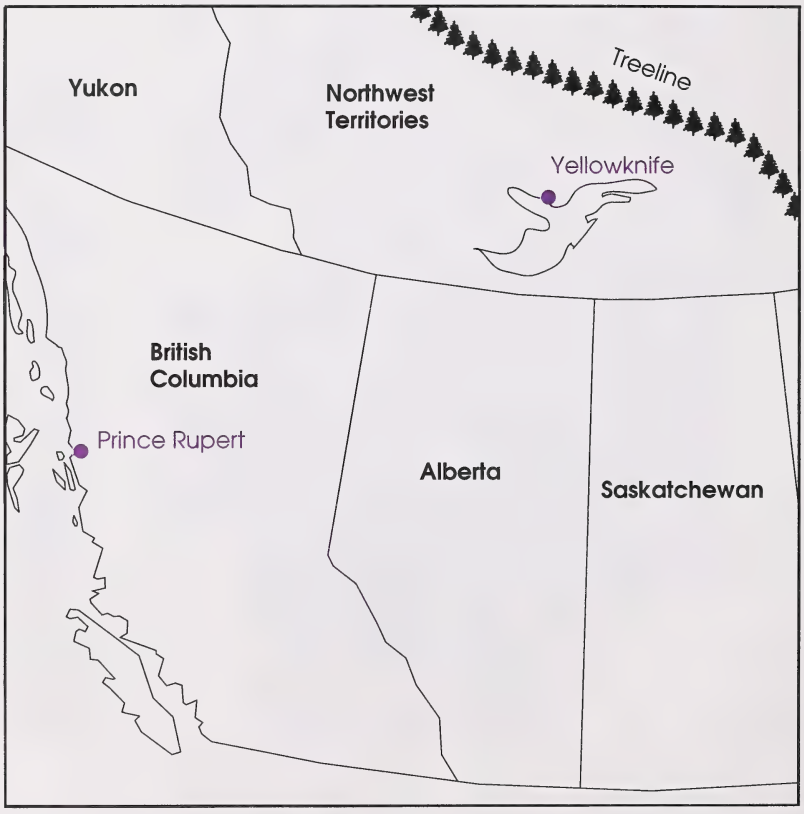


FIGURE 3.12 Locations for Climatograms

Figure 3.12 shows the locations of the climatograms which follow. Keep in mind what you know about the biomes in each of these locations from your own experiences as you answer the questions which follow Figure 3.13.

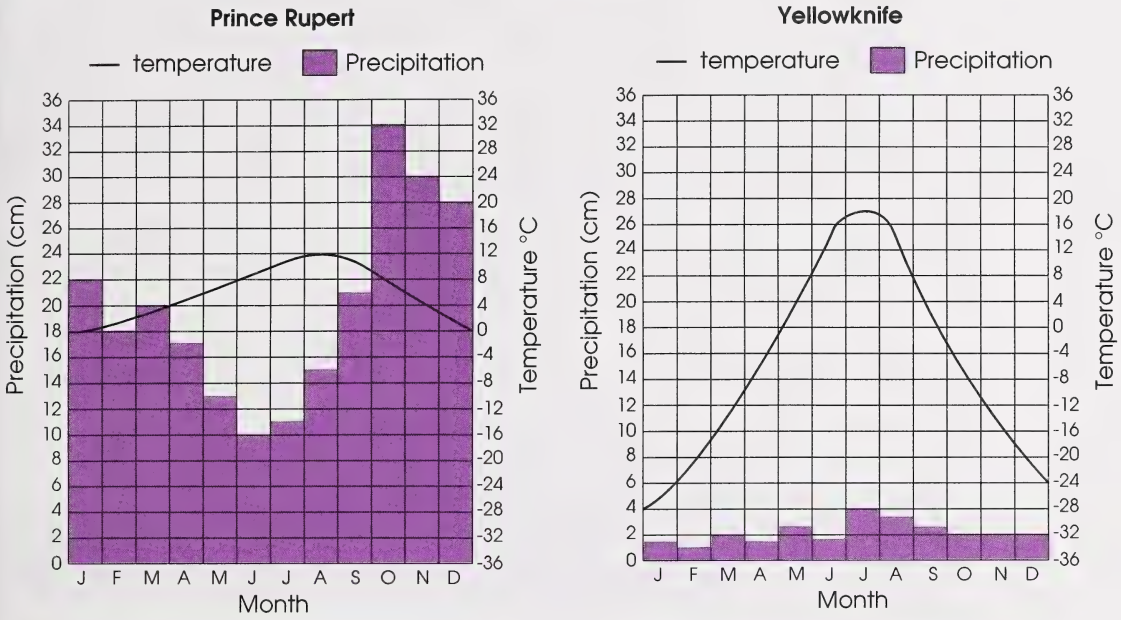


FIGURE 3.13 Climatograms for Prince Rupert, BC and Yellowknife, NT

Using Figure 3.13 answer the following questions.

9. In which month is precipitation heaviest in each location?

10. Which month is the warmest in each location? Read the temperature in the middle of the bar.

11. On average, how much warmer is Prince Rupert than Yellowknife in January?

12. How do you think the climate at each location has helped to create the biome?

Check your answers by turning to the Appendix, Section 3: Activity 2.

Science Skills
- ☐ A. Initiating
- ☐ B. Collecting
- ☑ C. Organizing
- ☑ D. Analysing
- ☑ E. Synthesizing
- ☐ F. Evaluating

Investigation: Drawing and Using Climatograms

Problem

What can a climatogram tell you about a biome?

Materials

- pencil
- paper
- climatogram data

Procedure

Step 1: Using grids similar to the one in the Analysis and Interpretation section that follows, draw the axes for three climatograms. Use the same scales as those in Figure 3.13. Give each graph an appropriate title.

Step 2: Plot the data from Table 3.2 on each graph. Use a different colour for temperature and precipitation. Plot the temperature in the middle of the square for each month.

Observations

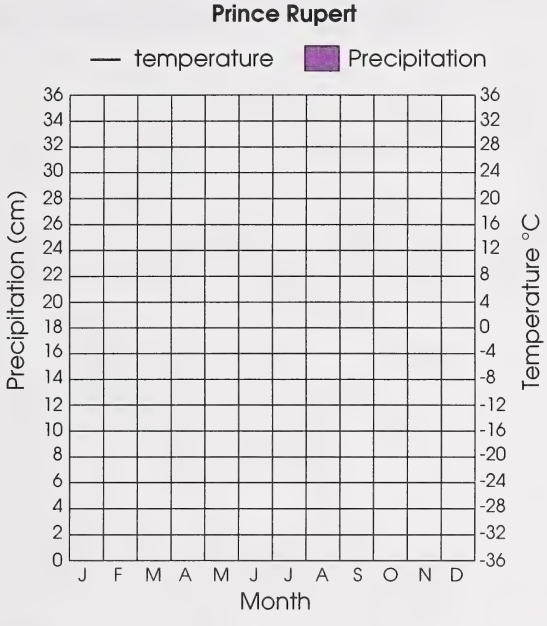
The following data were collected from three different biomes.

TABLE 3.2 CLIMATIC DATA FOR DIFFERENT BIOMES

MONTH	Biome A (altitude = 83 m)		Biome B (altitude = 330 m)		Biome C (altitude = 280 m)	
	Temp. (°C)	Prec. (mm)	Temp. (°C)	Prec. (mm)	Temp. (°C)	Prec. (mm)
January	26.7	262.0	10.4	18.0	–6.0	76.0
February	26.9	196.0	12.5	21.0	–5.6	65.0
March	26.7	254.0	15.8	17.0	–0.7	72.0
April	26.7	269.0	20.4	8.0	6.6	78.0
May	26.4	305.0	25.0	3.0	12.3	75.0
June	25.8	234.0	29.8	3.0	18.2	81.0
July	25.3	224.0	32.9	20.0	20.5	81.0
August	26.1	183.0	31.7	29.0	19.7	73.0
September	26.7	150.0	29.1	18.0	15.7	79.0
October	26.7	175.0	22.3	11.0	9.9	74.0
November	27.2	183.0	15.0	13.0	3.1	83.0
December	26.7	264.0	11.4	21.0	–3.6	87.0

Analysis and Interpretation

13. Draw a climatogram for each biome using the data in Table 3.2. Use grids similar to the one provided.



14. Make a chart similar to the one that follows. Complete the chart from the climatograms you have produced.

Condition	Biome Best Fits	Why
closest to equator		
seasonal temperature changes		
longest growing season		
highest annual precipitation		
measurable snowfall		
driest soil		
greatest variety of plants		
resembles the biome near you		

15. Using Figure 3.10 in this activity, name each biome from your climatograms.

Check your answers by turning to the Appendix, Section 3: Activity 2.

It should now be clear that studying the abiotic factors of an area can give you valuable information about biomes. In the next module you will learn more about the changes that occur within the biomes of the world and how one ecosystem can change over time.

Activity 3: Human Impact on Ecosystems

habitat – the region or area in which a species lives

Even the most urban-oriented person needs a constant, available supply of uncontaminated water, clean air, food, and space to live in relative comfort, safety, and harmony. Although people may not think of these needs as human **habitat**, those elements still are the basic requirements of our lives. The lands and waters that provide virtually all human needs also harbour most of our wildlife. And their capability to support fish, birds, and mammals is a good indicator of their capacity to meet the basic needs of man.

Pressures on habitat can be exerted by natural forces such as forest fires, extreme weather conditions, and landslides, or they may result from various human activities. Some of these activities are as follows:

erosion – the physical process of wearing down or weathering that is performed by abiotic factors within an ecosystem

- clear-cut logging that leads to soil **erosion**
- road construction that contributes to the degrading of fish habitat
- agriculture that eliminates forest, **wetland**, and prairie habitat

wetland – a region where there has been a pooling of water to form a pond, lake, or slough

1. What other human interactions with the ecosystems of your area may contribute to a serious problem?

2. You may have heard of forest management programs, conservation officers, or reclamation projects. Why are each of these important?

3. Explain the following statement in your own words.

> Endangered species cannot be preserved, but ecosystems can! This realization turns attention more to the necessity of preserving wilderness and natural areas – endangered spaces before endangered species.

Check your answers by turning to the Appendix, Section 3: Activity 3.

If you have flown over the prairie provinces, you may have noticed that the landscape is covered with small bodies of water. They were formed many, many years ago when the glacial ice sheets retreated. The hollows and potholes that were left behind filled with water and formed ponds and lakes. These areas are known as wetlands. Some of them form wherever there is low-lying land and water accumulates after heavy rains or snowmelt. Other wetlands form on the flood plains along rivers. Beaver dams and human dams can also build water reservoirs to form wetlands. Many wetlands have shallow water less than one metre deep.

TABLE 3.3 NET PRODUCTIVITY OF MAJOR CANADIAN BIOMES

Biome	Biomass ($kg/m^2/a$)	Stored Energy ($kJ/m^2/a$)
wetland	2.50	50 400
temperate rain forest	1.50	40 000
temperate deciduous forest	1.20	33 600
mountain coniferous forest	1.30	25 000
grassland	0.65	10 500
ocean	0.13	4 200
tundra	0.15	840
desert	0.13	840

4. Which is the most productive biome? Explain your answer.

5. Which is the least productive biome? Explain your answer.

6. Why do you think the mountain coniferous forest can have more biomass but less stored energy than the temperate deciduous forest?

7. What do you think might account for the low biomass and high energy in the ocean?

Check your answers by turning to the Appendix, Section 3: Activity 3.

To gain an appreciation of what is at stake in wetland habitats, familiarize yourself with the following questions and then view the Ducks Unlimited video, *If You Build It*. This video may be available through the Friends of Environmental Education Society of Alberta (FEESA) or through ACCESS Network. As you view the video, answer the questions. Pause the tape whenever necessary to write your responses.

8. Wetlands took thousands of years to develop. In one century, humans have destroyed most of them! List five methods of destruction.

9. Marshall, the narrator, suggests three management strategies that can be used to save the wetlands. Briefly explain each of them.

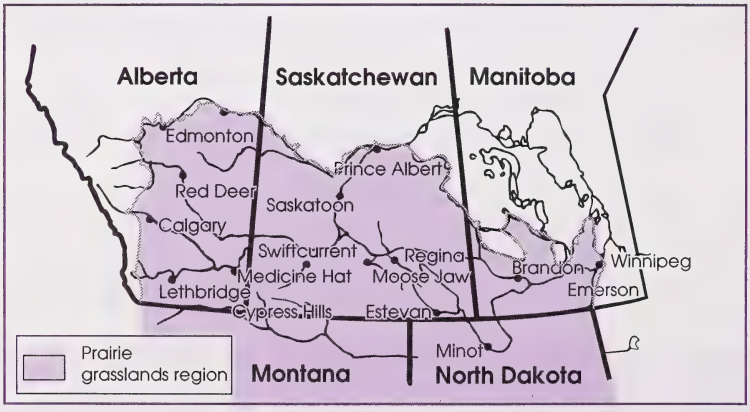
10. What did the wetland conservationists (Nathan, Katie, and Chris) find in each of their areas of Alberta?

11. List the management strategies that each of the conservationists could use to help save the wetlands.

12. What is the final message that concludes the video?

Check your answers by turning to the Appendix, Section 3: Activity 3.

Another area of Alberta that has been altered by human activity is the prairie grasslands region. Read the information provided. When you are finished reading, answer the questions.



The prairie grasslands region, also known as the prairie ecozone, is one of the most human-altered regions in Canada. Two of its native ecosystems, tall-grass prairie and plains fescue, have been almost eliminated. Less than 5% of the prairie grasslands region is protected at present.

Agriculture has produced the most drastic and extensive alteration of the prairies. About 87% of the prairie grasslands region is farmland, and about 44% is cropland.

The shift from grasslands to grain cultivation on the prairies tends to increase losses of soil organic matter and plant nutrients; it is estimated that the original organic matter levels in prairie soils have been reduced 40 to 50%.

Prairie wetlands provide critical habitat for more than 50% of North America's waterfowl.

The natural water systems have been extensively modified and intensively developed; reservoirs – for hydro and thermal power generation, irrigation projects, flood protection, and water management – have been developed on virtually every major river system in the grasslands region.

Although only about 2.4% of farmland is irrigated, irrigation accounts for 46% of water withdrawal; irrigation also accounts for 69% of total water consumption in the Prairie provinces.

Water quality is not getting significantly worse in most respects but is close to a minimal level at many locations, and current economic, social, and climatic trends may cause it to drop to an unacceptable level.

Economic development is at the limit of available water supplies in some basins in the Prairie provinces, and there are growing concerns in southern Alberta and Saskatchewan that increasing consumptive uses will prevent in-stream requirements of aquatic ecosystems from being met.[1]

13. Which portion of which provinces have prairie grasslands?

14. Identify two native ecosystems of the prairie grasslands that have almost been eliminated.

15. For each factor listed, explain how the human activities involved have contributed to the loss of the prairie grasslands.

    a. agriculture
    b. modification of natural water systems
    c. irrigation
    d. draining of sloughs
    e. urbanization

Check your answers by turning to the Appendix, Section 3: Activity 3.

[1] Taken from *Terrestrial Ecozones of Canada, Ecological Land Classification Series No.19,* 1986. Environment Canada, Lands Directorate.

Ecosystems are unique from an abiotic point of view. The challenge for the future – your future – is to preserve each ecosystem's unique heritage of soils, water, vegetation, and wildlife and to ensure the long-term benefits of a healthy environment!

Follow-up Activities

If you had difficulties understanding the concepts in the activities, it is recommended that you do the Extra Help. If you have a clear understanding of the concepts, it is recommended that you do the Enrichment.

Extra Help

In this section you have learned about the abiotic factors that contribute to the development of ecosystems. The distribution of these factors around the world produce large geographic areas that are very similar. Humans can destroy the balance in nature very quickly.

1. Make a chart similar to the one that follows. Organize the following terms into your chart.

   - air
   - altitude
   - chemicals
   - latitude
   - light
   - moisture
   - soil texture
   - temperature
   - topography
   - wind

ABIOTIC FACTORS WITHIN ECOSYSTEMS		
Climatic	Physiographic	Edaphic

2. How are the communities of an ecosystem affected by a decrease in the average daily temperature?

3. What effect will increased acidity of the soil have on the plants of an ecosystem?

4. Give two examples of altitude producing a change in the vegetation of an area.

Use Figure 3.14 to answer questions 5 and 6 which follow.

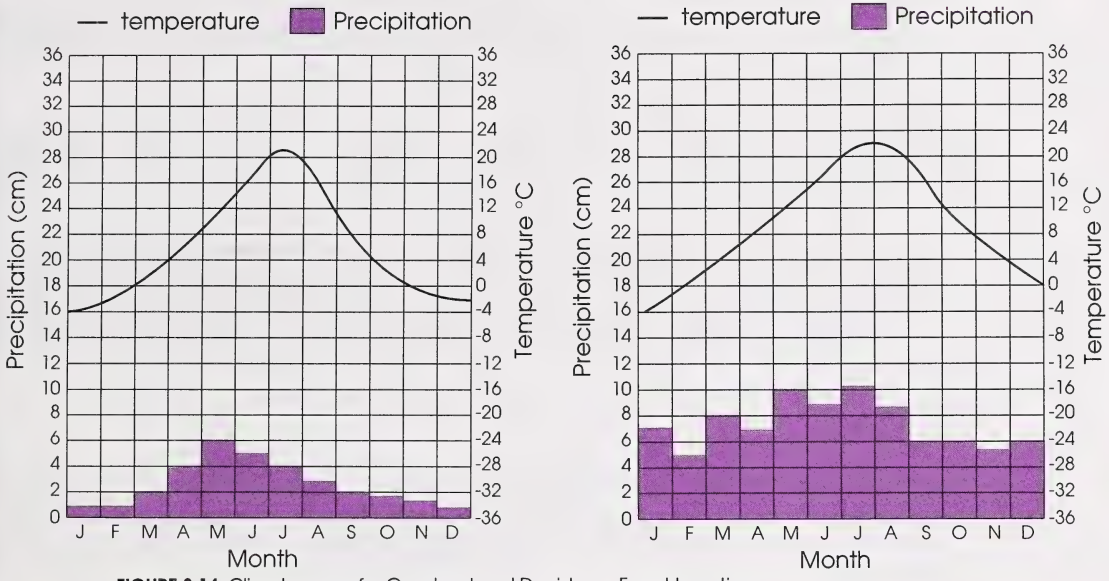


FIGURE 3.14 Climatograms for Grassland and Deciduous Forest Locations

5. The two biomes in Figure 3.14 are found at the same latitude. What abiotic factors would you expect to be similar?

6. What might be the main differences in abiotic factors between the two biomes in Figure 3.14?

7. What factors affect the quality of water in freshwater ecosystems?

8. Discuss the impact of the activities of humans on the wetlands and the grasslands of Alberta.

Check your answers by turning to the Appendix, Section 3: Extra Help.

Enrichment

1. Research the condition of your drinking water. Does it come from surface waters (river, lake, or stream) or from an underground well? Is the water purified or treated? What chemicals are used in the treatment process? What is the hardness and pH of the water?

2. Visit the local weather bureau to obtain the average monthly temperature and precipitation for your area. Construct a climatogram for your region and compare it to the ones in this section.

3. Obtain a copy of Canada's Green Plan from Environment Canada. Prepare a visual display for your school that explains some of the initiatives that have been taken by industry to better manage the environment.

4. Since wetlands are not only the most productive ecosystem but also the most endangered, find out what the province of Alberta is doing to conserve and restore its wetlands by writing to the Environment Council of Alberta.

Check your answers by turning to the Appendix, Section 3: Enrichment.

Conclusion

In this section you have studied ecosystems. They are defined by a range of abiotic and biotic characteristics. You have measured some of the abiotic factors and found that they have a significant effect on the biotic communities in ecosystems, especially the producers!

The climatic, physiographic, and edaphic factors for several ecosystems have been studied. You should now have a better understanding of how ecosystems differ from one another.

An introduction to the biomes of Alberta showed that large geographic areas are stable. There is a balance in nature. However, human activity can disrupt this equilibrium and the consequences may be devastating for the biotic communities. If efforts to restore the environment occur first, then the efforts to save individual species will be more effective. This is the only world you have, so take care!

ASSIGNMENT

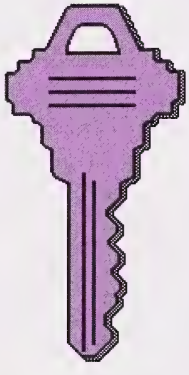
Turn to your Assignment Booklet and do the assignment for Section 3.

MODULE SUMMARY

The assortment of life on Earth is all around! The events within the biosphere that make life possible include a constant supply of radiant energy. Producers are able to capture this solar energy and convert it into useful chemical energy which is stored in their tissues. The flow of energy from organism to organism and the biogeochemical cycling of the raw materials for life combine to keep the biosphere in a dynamic equilibrium.

Ecosystems are a result of the interactions between abiotic and biotic factors. On a larger scale, biomes are the product of environmental conditions and living organisms. They are characterized by climax communities. Human activity can improve or degrade the character of a biome. Knowledge is the best weapon in the fight to save Earth from the ravages of human interference in the balance of nature. You are now well-equipped for that battle!

Appendix



- Glossary
- Activities
- Extra Help
- Enrichment

Glossary

abiotic: relating to the non-living components within ecosystems

acid rain: the result of pollution in the air that decreases the pH of the water which descends as rain

aquifers: water-bearing areas of sand, gravel, or permeable rock that lie above impermeable rock

biodegradable pollution: waste material that can be broken down by the actions of decomposers

biological magnification: the process whereby stable, non-excretable chemicals increase in concentrations as they are passed up the food web

biomass: the dry weight of an organism which is able to store energy

biomes: large regions of the Earth with a characteristic climate and type of vegetation

biotic: relating to the living components within ecosystems

cells: the basic structural and functional units of life

chemical energy: useful energy stored in molecules that can be used for the work of the cells

climatic: the weather conditions in an area that result from light, temperature, moisture, and wind

climatogram: a graph which summarizes the variations in temperature and precipitation in a biome

climax community: the dominant plant species that live in a particular area

community: all the living things in a certain area

decomposers: those organisms that break down the organic material in dead organisms

drought: a period without rain which makes an area dry

ecosystem: a self-regulating system of interactions between living and non-living components

edaphic: all of the factors that contribute to the formation of soil that acts as a foundation for communities

emissions: substances that are released from something, as when CO_2 and H_2O are formed during the burning of fossil fuels

erosion: the physical process of wearing down or weathering that is performed by abiotic factors within an ecosystem

food chain: the flow of chemical energy from one organism to another as they feed on one another

fossil fuels: energy molecules such as oil, gas, and coal that have been formed by the decomposition and compression of organisms that were once living

habitat: the region or area in which a species lives

harvesting: the processes involved in transferring chemical energy from one trophic level to another

herbicides: chemicals that are used to kill plants that are not wanted in a certain area

integral: essential or vital

limiting factors: the abiotic factors of an ecosystem for which there is competition among the living organisms

organic matter: carbon compounds that are found in living organisms

organs: groups of tissues that work together to perform the same function

organ systems: groups of organs that work together to perform the same function

pesticides: chemicals that are used to kill animals that are not wanted in a certain area

phosphates: complex ions of phosphorus that can be used to make nutrients

physiographic: the physical features of a geographical area that include latitude, altitude, and topography

pollutant: any chemical substance that can disrupt the health of a living organism

population: a group of individuals of the same species that live together in the same area

potable water: water that is suitable for human consumption

reclamation: the process of returning aquatic ecosystems to their original state

solar energy: the continuous flow of energy from the sun

specific heat: the capacity of a substance to change its temperature when heat is applied

thermal energy: heat energy which is lost into the atmosphere

tissues: groups of cells that perform the same function and look alike

transpiration: the process by which plants lose water from their leaves by evaporation

trophic level: a feeding level or role that a group of organisms perform within an ecosystem

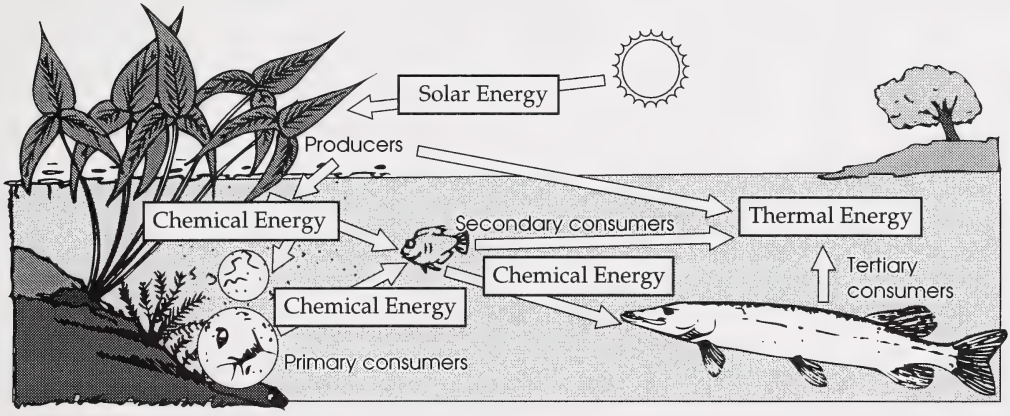
wetland: a region where there has been a pooling of water to form a pond, lake, or slough

Suggested Answers

Section 1: Activity 1

1. Recycling of matter makes it possible for life to exist. There is a fixed amount of raw material within the biosphere, so all organisms must use and reuse it. Decomposition makes it possible to convert dead, organic material back into the basic elements of life.

2. Your flow chart should be labelled as follows:



3. Your answer could include the digestive, respiratory, nervous, circulatory, excretory, or skeletal systems.

4. The major organs of the systems shown in Figure 3.1 are as follows:

- digestive – esophagus, stomach, intestine, liver, pancreas
- respiratory – nasal cavity, trachea, lungs
- nervous – brain, spinal cord, receptors (eye, nose)
- circulatory – heart, arteries, veins
- excretory – kidneys, lungs, skin
- skeletal – bone, cartilage

5. Most of the organs in the human body have lining tissue, nerve tissue, and connective tissue like blood. The hollow organs also have muscular tissue to move the fluids that fill the organ.

6. There are many different organisms shown in Figure 3.2 that could represent the populations of the pond. They include the fox, mouse, goose, owl, heron, hawk, fish, crayfish, snail, and frog.

7. This ecosystem is aquatic. Therefore, the major abiotic component is the water in the pond.

8. It is also important that there is a normal atmosphere with an abundance of solar energy. The soil is another abiotic part of the ecosystem that is essential for the natural processes to occur.

9. Your chart could include the following answers.

HUMAN BEING		BIOSPHERE	
Level	**Example**	**Level**	**Example**
cell	blood	organism	bird
tissue	skin	population	grass
organ	heart	community	all organisms
system	digestive	ecosystem	pond
organism	human	biosphere	all life on Earth

10. An ecosystem

- is the fundamental unit of ecology
- consists of communities of plants and animals interacting with each other and their environment
- is a physically and biologically distinct region
- varies in size and complexity and merges into another ecosystem
- is influenced by adjacent ecosystems and interacts with them
- is an area where energy is processed by populations

11. Tropical ecosystems enjoy a more stable environment. Therefore, they can become more complex. As a result, they are able to deal with change more effectively. Since the arctic environment changes quite dramatically during the year, this ecosystem is less stable. The loss of one population could be disastrous because there are few that can survive the changes. Hence, the arctic ecosystem remains relatively simple.

12. Human interventions that have benefited ecosystems may include the following:

- weather modification where silver iodide crystals are used to seed clouds and reduce the size of hailstones
- controlled burning that can release seeds to populate new areas
- reforestation that aerates soil, allowing new populations to grow
- use of a fungus to infect the larvae of the mosquito population to control this pest without affecting the other populations

13. Phosphates greatly increase the process of eutrophication, which leads to almost uncontrolled growth of algae and other aquatic plants. The subsequent overpopulation increases decomposition and oxygen consumption which alters food chains, webs, and pyramids.

14. The sources of acid rain in Alberta include the tar sands, gas plants, and motorized vehicles. As the pH drops, plants and animals begin to die, leading to the death of certain aquatic ecosystems.

15. Reclamation is primarily concerned with restoring an ecosystem to its natural state. The main focus is water and the treatment of water, since it plays such an important role in all ecosystems.

Section 1: Activity 2

1. a. An ecosystem is a natural unit of living organisms and non-living components for which there is competition in a specific area.

   b. Solar radiation is the continuous flow of energy from the sun that creates the conditions necessary for life on the Earth.

   c. Photosynthesis is a process in which plants convert solar radiation into potential chemical energy and store it in the form of glucose molecules.

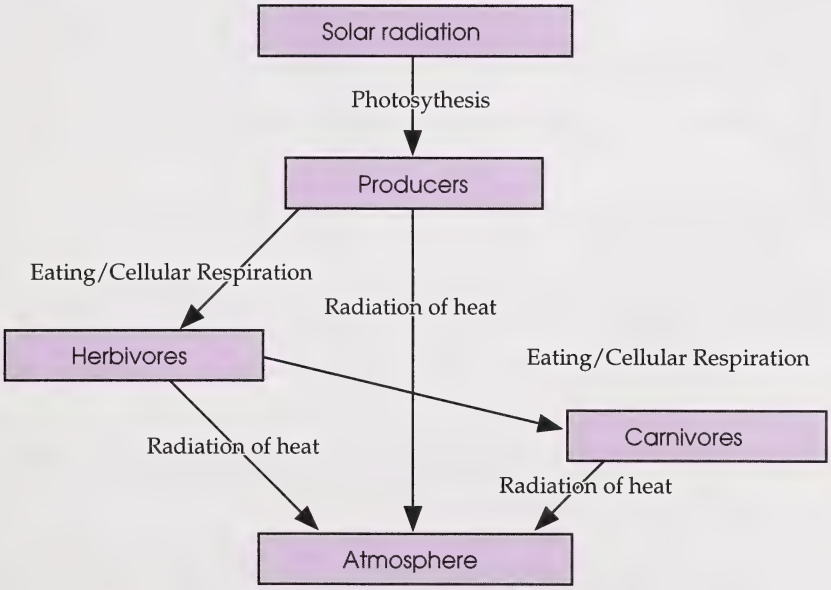
   d. The chemical process that releases the stored energy from glucose and other organic molecules is called cellular respiration.

   e. Producers are organisms that perform photosynthesis.

   f. Herbivores are primary consumers that eat plants.

   g. Carnivores are secondary consumers that eat other animals.

2. Your concept map should look like the one that follows.



3. Since not all parts of the Earth receive the same amount of sunshine, there will be a variety of environments in which ecosystems can thrive. The fertility of each area will be determined by how large the producer populations become.

4. Producers convert solar energy into chemical energy during the process of photosynthesis. Pigments capture the energy and a series of chemical reactions convert it into chemical energy.

5. Herbivores will use the chemical energy they harvest from the producers for growth, reproduction, and maintenance activities. They will also store some of it in their tissues and lose some of it as heat, which is radiated from their bodies into the atmosphere.

6. Table 4.2 on page 120 of the textbook summarizes this concept. The producers receive energy directly from the sun. They use less energy than herbivores and carnivores use to live; so there is more energy stored in their tissues. The herbivore feeds directly on the producer but is able to harvest only about 20% of the energy. Since the herbivore uses about 90% of the energy it gets, there is much less energy available to the carnivore.

7. The essential role of the decomposers is to break down the organic matter that is incorporated into the bodies of plants and animals. This allows the important recycling of raw materials within the ecosystem so new organisms can use them and grow.

8. The frog is a consumer known as a primary or first-level carnivore.

9. There is no organism in this food chain that eats the hawk; therefore, it is at the top of the trophic levels.

10. If all the grasshoppers die, then the numbers of producers would increase because there would be no organisms to feed upon them. Without grasshoppers, the frogs would experience a greater competition for food and this would lead to a decrease in the numbers of this population. The snakes would then have less food and would also decrease in numbers. This, in turn, would starve the hawks.

11. When there is no water in an area, the producers are the first to suffer and their numbers would decrease the most.

12. The producers store the greatest amount of chemical energy because the most energy is available to them; they use the least energy to live; and they are in the greatest abundance.

13. The top carnivores will store the least energy because there has been a significant loss of energy at each trophic level in the pyramid and these organisms are the farthest from the source of energy.

14. Harvesting is not 100% efficient because some of the energy is used by the organisms to live and some is lost into space as heat.

15. The organisms at each trophic level lost energy through cellular respiration and the radiation of heat. Therefore, the tissues of their bodies will store less than the tissues of the organisms they eat. Therefore, the base of the pyramid will represent the most energy.

16. The energy stored should be used to construct the pyramid. This will be the energy available to the next level. The proportions of energy stored by animals depends on whether they eat plants or animals. Storage of plant food is much less efficient than the storage of animal food.

17. Every organism, whatever its mass or life span, is given equal status. This does not paint a very accurate picture since organisms vary so much in size and significance to an ecosystem.

18. In the grassland there would be more producers in the summer than there would be in the winter. The forest would have about the same number of producers in the winter and the summer. There would be far fewer primary consumers in the winter in both ecosystems.

19. Over a period of time the herbivores would eat several generations of producers because the life spans of the producers are shorter.

20. Unfortunately, one gram of rabbit and one gram of mouse are not the same. They will not supply a fox with the same amount of energy. Different types of tissues have different energy contents. The most noticeable difference occurs between plant and animal tissue. You can usually obtain about 20% more energy by eating one gram of animal tissue that you can by eating one gram of plant.

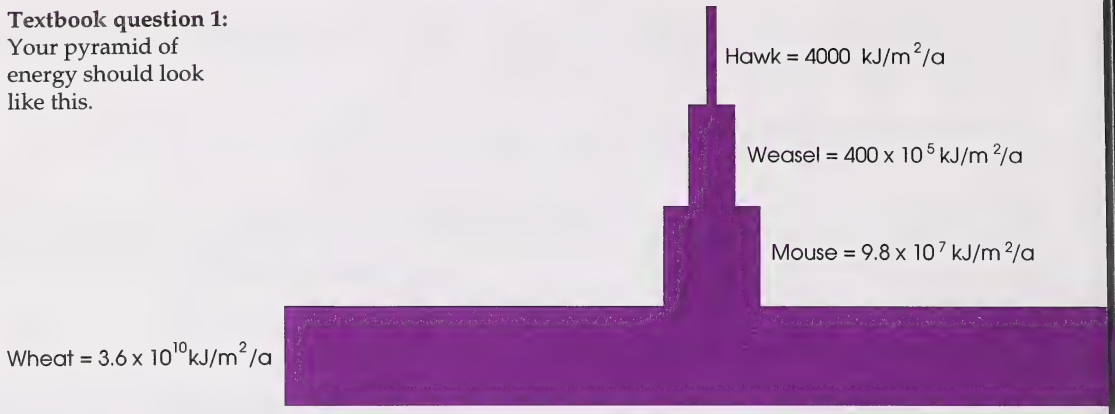
21. The calculations are shown in the following chart.

Organism	Daily Energy Requirement (kJ)	Yearly Energy Requirement (kJ)	Energy Provided by Previous Trophic Level (kJ)	No. of Organisms from Prev. Trophic Level Required to Feed One Organism for 1 Year	Total Population	Energy Stored at Each Trophic Level (kJ)
hawk	330	120 450	400 (per weasel)	301 weasels	1	4000
weasel	80	29 200	100 (per mouse)	292 mice	1003	4.0×10^5
mouse	20	7300	12 (per wheat plant)	608 wheat plants	9.8×10^5	9.8×10^7
wheat plant	5.5	2008	—	—	3.0×10^9	3.6×10^{10}

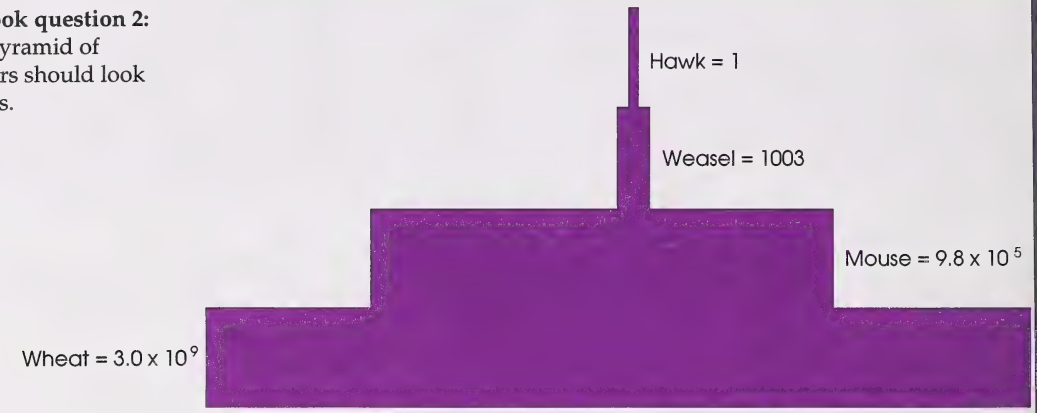
Remember to expand the numbers of organisms required for one year's energy supply by determining the total population and multiplying by the number of organisms that will be eating them. That means that one hawk eats 301 weasels. The total population is $301\times\frac{100}{30}=1003$ weasels. However, each weasel eats 292 mice, so there are $1003\times292=292\,876$ mice eaten! The total mouse population will then be $292\,876\times\frac{100}{30}\doteq9.8\times10^5$. Also remember that if one weasel can store 400 kJ of energy, then 1003 weasels will store 4.0×10^5 kJ of energy at that trophic level. (Note: The mice eat only 20% of the wheat plants.)

22. The area of wheat needed to support one hawk for one year is $3.0\times10^9\times5\,\text{cm}^2=1.5\times10^{10}\,\text{cm}^2$ or $1.5\,\text{km}^2$.

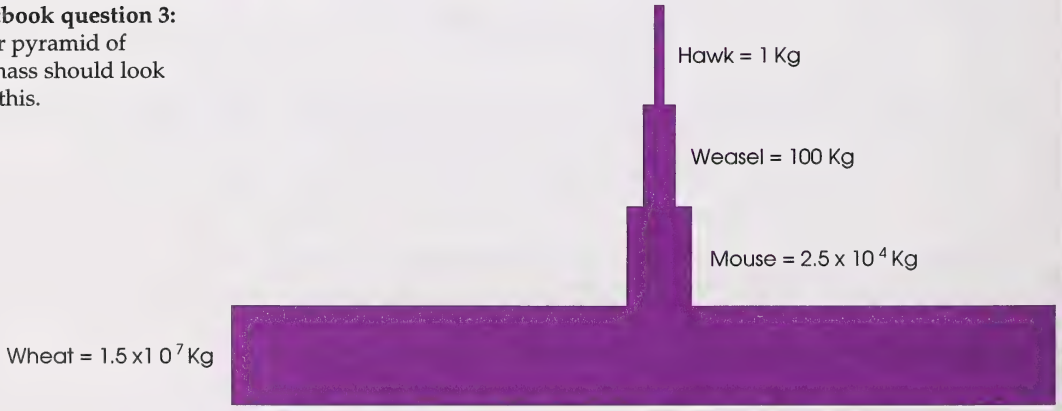
23. **Textbook question 1:**
Your pyramid of energy should look like this.



Textbook question 2:
Your pyramid of numbers should look like this.



Textbook question 3:
Your pyramid of biomass should look like this.



24. **Textbook question 1:** The producers receive the greatest amount of energy, while the tertiary consumers (secondary carnivores) receive the least.

Textbook question 2: Secondary consumers will eat primary consumers as well as other secondary consumers. In some cases, they will also eat producers.

Textbook question 3(a): Hawks may eat mice or other rodents they are able to catch in the fields.

Textbook question 3(b): No, there will be different generations that are alive at the same time and the predators will usually eat those that are least able to avoid them. This may include the very old and the very young.

Textbook question 3(c): It is obvious that there must be a male and a female of each kind of organism if there is to be the production of new members of that population. Without this, the population would become extinct very quickly. However, in terms of daily energy requirements, there must be sufficient organisms to meet the daily energy requirement of the next trophic level.

Textbook question 3(d): Energy that is not available for transfer from one trophic level to another is lost into the atmosphere as thermal energy and used in the processes that keep the organism alive.

Textbook question 3(e): Decomposers use the energy that is not transferred within trophic levels or transferred to the next higher trophic level. They receive energy from all the other levels when the organisms die.

Textbook question 5: All the pyramids are very steep because of the energy, numbers, and biomass in the lower two trophic levels being so much higher than in the other levels. The efficiency of energy transfer in this example is very low. The hawk receives only 1% of the energy stored in the weasels. The weasels receive about 0.4% of the energy stored in the mice, and the mice only receive about 0.3% of the energy stored in the wheat plants. Thus the tertiary consumer (hawk) is harvesting far less than 1% of the energy of the sun. You can see that is takes a large amount of energy from the sun to sustain one hawk.

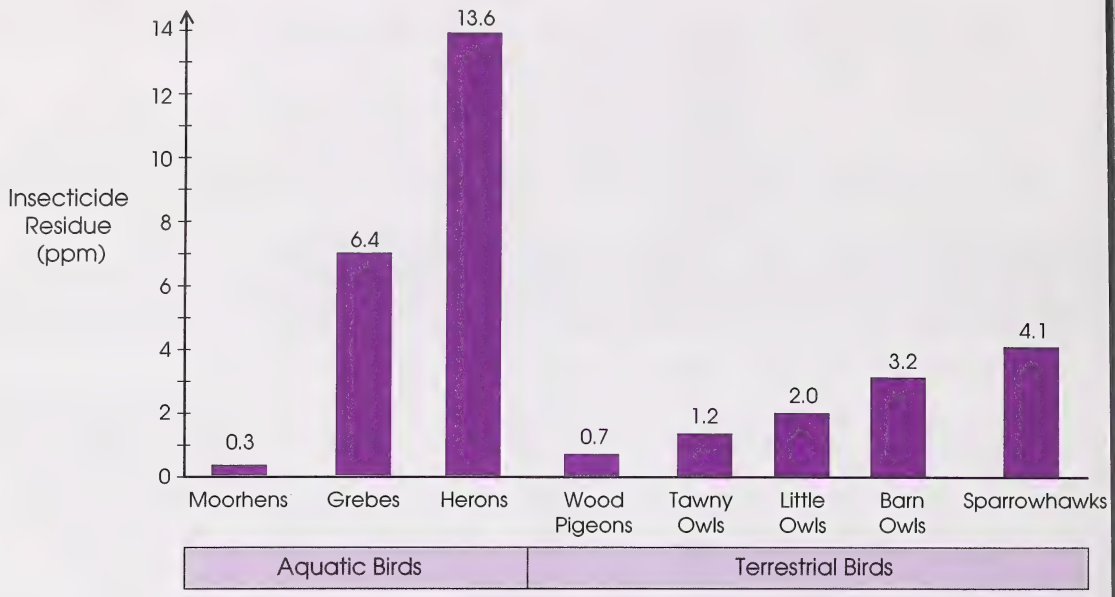
Section 1: Activity 3

1. Biological magnification is the process whereby toxic chemicals accumulate in the tissues of organisms and increase in their concentration as they are passed from one trophic level to the next toward the top of a pyramid.

2. The tertiary consumers occupy the most dangerous position. As biomass is transferred from one trophic level to the next, the toxins become increasingly concentrated. Therefore, the highest trophic level acquires the greatest amount of toxic chemicals from its food.

3. The effect of DDT on peregrine falcon egg formation, the accumulation of methyl mercury in aquatic systems near Yellowknife, and the mercury poisoning in Minamata Bay are excellent examples of how biological magnification has affected the pyramids of numbers and biomass.

4. Your bar graph should look like the one that follows.



5. These birds must be herbivores. They will contain the least DDT because they are at the lowest trophic level.

6. If these birds were herbivores, then their DDT concentration would be very low like the moorhens and the wood pigeons.

7. The aquatic environment creates the highest biological magnification according to the data. Therefore, birds in this habitat may be more seriously affected because of the high levels of DDT.

8. The pyramid of numbers will increase in width showing more organisms because there is more food available to them.

9. The decomposers will have more dead organisms to feed upon as a result of the increase in numbers and waste production.

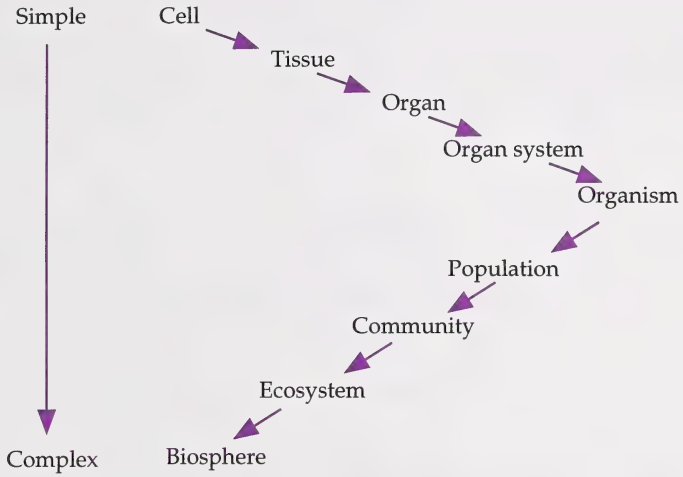
10. There will be greater competition for oxygen by those animals that require it for cellular respiration. Many will die.

11. The lack of oxygen will lead to the death of more animals. This is how a lake can die and still be covered with plants like the algal bloom shown in Figure 3.4. This is the result of eutrophication.

Section 1: Follow-up Activities

Extra Help

1. Your flow chart should look like the one that follows.



2. Each level requires a supply of raw materials as well as a supply of energy in order to produce organic material and grow.

3. There must be a constant input of energy from the sun, as well as constant cycling of matter, to keep an ecosystem functioning properly.

4. You eat food that provides you with the chemical energy necessary to perform all your activities including maneuvering the car or hanging onto the kite.

5. The producer stores less energy in its tissues than the same amount of carnivore. As you have learned, the harvest from the plant will be less than the harvest from the animal. There is a difference in the amount stored because animals are more efficient in storing energy. (See Table 4.3 on page 123 of your textbook.) Animals do not have the luxury of a constant supply of energy like plants receive in the form of continual solar radiation.

6. The producer will store solar energy in the form of carbohydrates, like glucose, which are the products of the photosynthetic process.

7. Ultimately, all energy comes from the sun. Since plants are the primary producers, you should thank a plant today!

8. A sample food chain is shown. Your answer should include a producer, a primary consumer, a secondary consumer, and you.

   grass ⟶ insects ⟶ ducks ⟶ you

9. The three major trophic levels shown in Figure 3.5 are producer, consumer, and decomposer.

10. Your completed chart could look like the one that follows. Other examples are possible.

Trophic Levels	Food Chain 1	Food Chain 2
producers	shrubs	grass
herbivores	mice	rabbits
decomposers	snails	mushrooms

11. Each trophic level in the ecosystem processes energy. The producers trap solar energy and transform it into chemical energy for all of the other levels. The consumers are able to use the chemical energy. The organic material in producers and consumers is returned to the abiotic part of the ecosystem when the organisms die and decomposers perform their essential function.

12. Your pyramid of numbers should be labelled as shown.

13. The carnivore level would contain the most chemical. As the chemical accumulates in the organisms of the food chain, it becomes concentrated at higher levels. Thus, the animals at the highest trophic level will receive the most concentrated amounts of chemical.

Enrichment

1. You can obtain a copy of the Canada Food Guide by contacting the nearest Government of Canada, Department of Health and Welfare office. This will help you when you visit your local supermarket and survey the foods that are available. In general, meats and fish will provide the most energy, but find the price per unit of energy provided to see which foods give the best value.

2. Consult the Canada Food Guide for specific information about your diet. Substituting more fatty foods will provide you with more energy per unit of biomass. However, your body's preferred energy source is carbohydrates. Cells can use carbohydrates more easily than fats.

3. The results of this activity will vary greatly depending on where you live. Use the library in your school or town to help you find out more about the organisms in your area and their feeding habits. The food chains and food webs you create will all begin with producers and end with some top consumers.

4. Once a grain of wheat is planted and germinates, it begins to photosynthesize. Solar energy will be trapped in the formation of carbohydrates. The carbohydrates will be stored as chemical energy in wheat plant tissues. From the information in your textbook, you know that about 60% of the energy harvested from the sun is stored by the plant. The remaining 40% is used to live or lost as heat. When the wheat is harvested and milled, it can be used to make bread. If there are pollutants in the soil where the wheat is grown, there is a good chance that biological magnification will take place and you will get an increased concentration of the chemical. Hopefully, there will not be enough to make you ill or cause other long-term effects.

Section 2: Activity 1

1. Solar energy is the major form of energy that makes the hydrologic cycle work. The cycle is also influenced by the heat energy in water.

2. The abiotic processes are evaporation and precipitation. The biotic processes are transpiration, which is evaporation from plants, and cellular respiration in plants and animals.

3. Water will only stay in the atmosphere for about ten days before it returns to the Earth as some form of precipitation.

4. The water that is found on the Earth in solid and liquid form represents 99% of the total. Most of it (97%) is found in liquid form in the oceans of the world.

5. When water vapour condenses, it may form fog, mist, steam, or clouds. These are forms of water droplets suspended in the air.

6. Human activities that are dependent upon water include transportation, shipping, recreation, generation of electricity, irrigation, and industry.

7. Groundwater acts as the major source of this liquid for agricultural purposes. Plants can also absorb water from the ground for use in photosynthesis.

8. Sewage treatment is essential to restoring the quality of water being returned to the hydrologic cycle. In the primary stage, settling and scooping remove grit and other solid particles from the sewage. Skimming removes oil and grease that float on the top of the water. In the secondary stage, air is pumped into the water to allow bacteria to decompose organic wastes. Chlorine may also be added to the water to kill organisms that can contaminate it. After a few days, the water is returned to the river.

9. Refer to the answers provided for Section 2, Activity 1, questions 4 to 8.

10. Answers will vary depending on the amount of precipitation and rate of evaporation. The following is a sample of the data you should obtain.

Container	Precipitation or Evaporation (mm/d)						
	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
container for collecting precipitation	6 mm	0 mm	25 mm	0 mm	0 mm	42 mm	0 mm
container for precipitation control	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm	0 mm
container for evaporation	50 mm	42 mm	39 mm	30 mm	24 mm	20 mm	17 mm
container for evaporation control	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm	50 mm

11. **Textbook question 1:** Obviously, the differences in your data will reflect the weather conditions over the time you collected information. Since the amounts will vary greatly from season to season, it would be much more accurate to actually carry out the collecting rather than just converting your results to an annual basis.

Textbook question 2: Assuming that your classmates live in the same area as you, their results should be the same. If the data were collected over several years by many classes in the area, this would help give a more complete picture of the hydrologic cycle in your area.

Textbook question 3: Some of the factors that you should have in your list for evaporation include air temperature, daylight hours, amount of surface area water exposed to the air in the area, wind speed, relative humidity, and air pressure. The factors that influence precipitation include altitude of the area, air temperature, air pressure, and cloud cover. The weather patterns from other areas will also have an impact on evaporation and precipitation in your area. Consulting with the weather offices in the area will help you obtain accurate information.

Textbook question 4: Short-term observations tend to be less accurate because weather is relatively unpredictable. Predictions are based on general information gathered over a long period of time. The conditions are changing as time passes, so this will affect your actual results.

Textbook question 5: When comparing data, the consistency will be based on the accuracy and time frame of collection. The previous answers will generate the hypotheses for explaining any deviations.

12. Water will remain on land for 10 to 120 days. It may become runoff water, capillary water, or gravitational water found in the water table.

13. Runoff water can be absorbed and stored by plants. It can also pool in reservoirs like rivers and lakes where it may be available to plants and animals.

14. Aquifers store water and supply over half of the world's population with potable water.

15. The problem of clean water is compounded by the vast number of pollutants that are continually being added to the aquifers of the world. Also, water supplies and human populations are unevenly distributed across the Earth.

16. Pollutants enter the aquifers by leakage from sewers and basins, discharge from septic tanks or cesspools, and percolation from landfills and fertilizers spread on the land.

17. From the information given in Figure 3.6, the most important source of potable water is the Artesian aquifer that contains fresh water. The water table aquifer will also provide potable water, but it is more likely to be polluted.

18. Human activities must change. Reducing the amount of pollutants by creating fewer pollutants and distributing water more carefully will help to solve the problem.

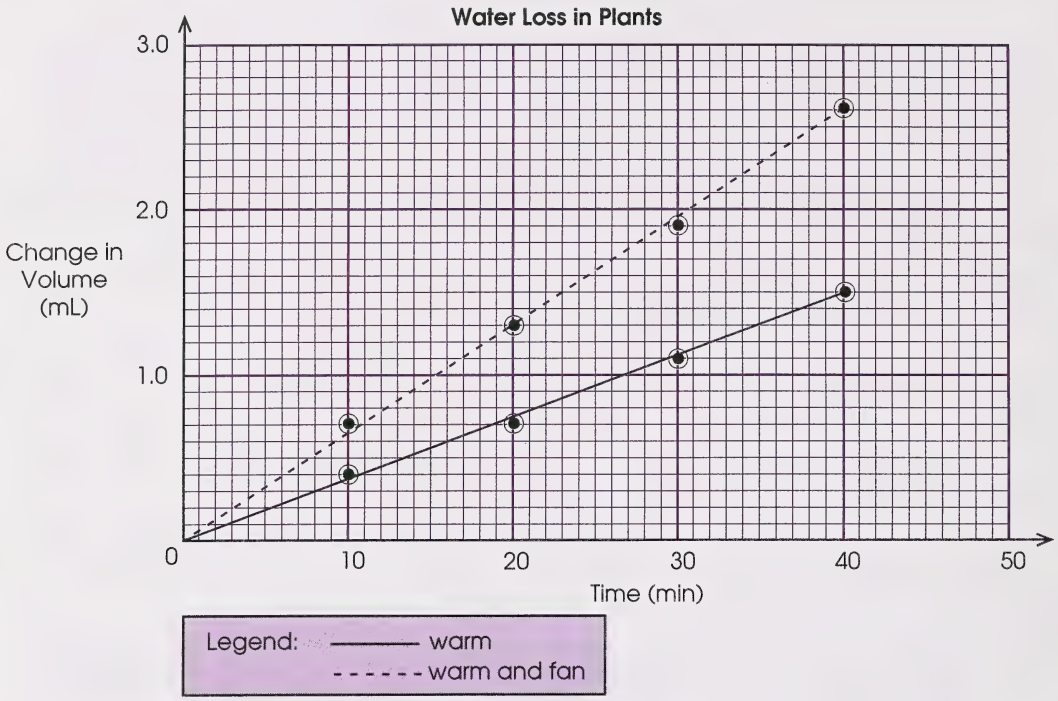
19. Results will vary. If you cannot get a measurable rate of transpiration, try another plant cutting or try extending the length of time observed. The following tables give a sample of the results you could get for this investigation. (Note: The change in volume is an accumulated change.)

Time (min)	Scale Reading (mL)		Change in Volume (mL)	
	Warm Area	Fan	Warm Area	Fan
0	20.0	18.5	0	0
10	19.6	17.8	0.4	0.7
20	19.3	17.2	0.7	1.3
30	18.9	16.6	1.1	1.9
40	18.5	15.9	1.5	2.6

20.

Measurement	Warm Area	Fan
Total volume of water lost (mL)	1.5	2.6
Total time elapsed (min)	40	40
Average rate of water loss (mL/min)	0.04	0.07

21. A sample graph is given as follows. Your data should produce something similar.



22. The amount of water lost by transpiration will increase in a warmer location. This will give you greater variation for graphing.

23. Increasing the air speed will increase the transpiration rate. This should be evident on your graph.

24. Air temperature will affect water loss because plants and animals can maintain constant temperatures by cooling themselves through evaporation processes. Increases in air speed will cause plants and animals to dry out more. Both of these conditions will cause plants and animals to consume much more water in order to maintain a constant supply of hydration.

Section 2: Activity 2

1. The global free oxygen supply is the reservoir of atmospheric oxygen and the oxygen dissolved in the hydrosphere. Most of the oxygen in the biosphere exists in chemical combination with other elements.

2. Photosynthesis removes CO_2 from the atmosphere and converts it into new organic matter.

3. Decomposers break down organic matter that contains carbon and return this element to the air as CO_2. Other products can be absorbed by plants to be reused.

4. The processes of photosynthesis and cellular respiration are basic to the cycling of carbon and oxygen in the biosphere.

5. Your chart should be similar to this one.

Processes that Increase Atmospheric O_2	Processes that Decrease Atmospheric O_2	Processes that Increase Atmospheric CO_2	Processes that Decrease Atmospheric CO_2
photosynthesis weathering	combustion decomposition aerobic respiration cellular respiration oxidation (rusting)	aerobic respiration decomposition combustion volcanic eruption	photosynthesis dissolution in oceans

6. Carbon is stored in biomass, rocks, and fossils. Much of the oxygen is stored as carbonates in minerals below the Earth's surface.

7. The carbonates react with acids to produce CO_2 which enters the air and is available to plants. Decomposition also makes carbon available to living organisms once again. Carbon will enter the cycle again when fossil fuels are burned.

8. Molecular oxygen absorbs ultraviolet light and forms ozone. Ozone is important to organisms on Earth because its formation reduces the amount of harmful ultraviolet radiation that reaches the Earth.

9. James Lovelock, a British scientist, proposed the Gaia hypothesis. It states that life itself determines and controls the conditions that continue to make the Earth habitable. This suggests that life on Earth is interconnected. It is a reminder of a basic principle of ecology – you can never change just one thing!

10. The major molecules of life function as follows in living cells:

    - Nucleic acids provide information for control.
    - Proteins act as biological catalysts.
    - Carbohydrates contain energy for activity.
    - Lipids form the boundary or membrane.

11. The earliest form of life appears to be an ancient bacterium. As evolutionary processes continued, these organisms began to perform photosynthesis. This added oxygen to the atmosphere by removing the carbon dioxide.

12. Research suggest that carbon atoms will remain in the atmosphere as CO_2 for about twenty years. Plants will then capture this gas and transform it into a carbohydrate.

13. The biochemical cycles are the continuous cyclical movement of the chemicals important to all living organisms on Earth. These cycles are important to life on Earth because they allow organisms to continually obtain the elements essential to life.

14. Oxygen is a part of the carbon cycle. The use of carbon through photosynthesis releases oxygen to the atmosphere. At the same time, oxygen is used during the production of carbon dioxide through combustion or decomposition.

15. Hydrogen is a part of the carbon and oxygen cycles through photosynthesis and cellular respiration. Photosynthesis utilizes the hydrogen in water and carbon dioxide to form carbohydrates and oxygen. Cellular respiration frees the hydrogen in carbohydrates to form water and carbon dioxide.

16. Through increasing combustion, human activity has raised the levels of carbon dioxide in the atmosphere by about twenty-five percent.

17. Total O_2 produced $= 10\ mL/h \bullet g \times 20\ h \times 1\,000\,000\ g$
$= 2.0 \times 10^8\ mL$

Since the O_2 produced equals the CO_2 consumed, the production of CO_2 by plants and animals must equal $2.0 \times 10^8\ mL$.

18. Total CO_2 produced $= 5\ mL/h \bullet g \times 4\ h \times 1\,000\,000\ g$
$= 2 \times 10^7\ mL$

19. Total CO_2 produced by the astronauts per day is $= 2.0 \times 10^8\ mL - 2 \times 10^7\ mL = 1.8 \times 10^8\ mL$. The total O_2 used equals the total CO_2 produced. Therefore, the total O_2 used by the astronauts would be $1.8 \times 10^8\ mL$.

$$\text{Total mass of the astronauts} = \frac{1.8 \times 10^8\ mL}{5\ mL/h \bullet g \times 24\ h}$$
$$= 1.5 \times 10^6\ g \text{ or } 1.5 \times 10^3\ kg$$

Assuming each astronaut has a mass of 75 kg, there would be $1.5 \times 10^3\ kg \div 75\ kg = 20$ astronauts in this space station.

20. A nitrate is an ion produced when nitrogen and oxygen are bonded together chemically.

21. Nitrogen fixation occurs abiotically when lightning causes N_2 to react with O_2 and produce NO_3. Thunderstorms can produce rain with nitrates in the drops. Nitrogen-fixing bacteria grow on the roots of legumes. This biotic process also creates nitrates.

22. These bacteria break down nitrates in the soil. This reduces the amount of nitrates that grass uses to produce proteins like chlorophyll that make your grass green. This is why the lawn does not have a rich green colour.

23. The legumes allow nitrogen-fixing bacteria to produce nitrates. There are usually more produced than are required. The excess serves as a fertilizer in the soil for other plants. If the rows are moved to new locations in your garden each year, you can continue the natural fertilizing process.

24. Soil fertilizers have been used to restore the depletions created by harvesting crops. These additions to the soil can maintain a balance and allow repeated harvesting.

Section 2: Activity 3

1. Simple forms of recycling include feeding kitchen peelings to farm animals and reusing old wood to build new structures.

2. The items that you could recycle might include the following:

Items at Home	Items at School
sorted paper	sorted paper
sorted cans	sorted cans
sorted plastic	sorted plastic
organic waste by composting	motor oil from mechanics class

3. Recycling programs attempt to return the materials of our industrial world to some usable form. In this way there should always be a supply of raw materials from which new things can be made. The biogeochemical cycles serve the same purpose.

4. Using raw materials, humans make products that can be used. Once the product has been used, the disposal of waste occurs. Therefore, the garbage production by humans involves the sequence make – use – dispose.

5. Humans consume excessively large amounts of raw materials and energy. This leads to tremendous pollution and garbage production.

6. The burning of the waste reduces its volume by up to 90% before the ashes are taken to a landfill. The heat produced is used to generate electricity, enough to provide one third of the community's needs.

7. The aluminum cans are compressed and shredded first. Then they are melted and formed into ingots. The ingots are squeezed into sheets, rolled into coils, and then manufactured into recycled cans.

8. The cost will include the purchase of more landfills, higher taxes, higher garbage collection fees, more equipment and staff, greater contamination, and fewer raw materials available for use.

9.

Risks	Weighting	Benefits	Weighting
• leakage through injection pipe wall that could cause water table contamination	low	• disposal of material that otherwise may pose a threat on the surface	high
• leakage through cracks in rock layers	unknown	• relatively inexpensive way of disposing of hazardous wastes	high
• possible earthquake damage	low		
• chemical reaction with rocks	unknown		

10. The textbook suggests that there are still many questions to be answered about the safety of such a practice. There are several risks. Some are weighted low and some are of unknown consequence. There are two definite benefits which are weighted high.

11. If there is no leakage, then your opinion would most likely be positive. The benefits would outweigh the risks and this process could be used extensively.

12. Chances are that you would be reluctant about such a well near your home until the questions raised in the textbook have been answered. After all, your drinking water may be affected by those radioactive isotopes, and you do not want to become a mutant!

13. The video provides the following answers.

Activities that Increase Greenhouse Gases	Activities that Decrease Global Warming
• burning fossil fuels to produce electricity, run automobiles, and remove forests • engaging in garbage disposal and decomposition • using refrigeration and coolants • manufacturing and using styrofoam • using fertilizers in soil	• switching to renewable energy such as solar energy, wind energy, and electric cars • using energy more efficiently through government laws, building designs, recycled heat, better light bulbs, insulated attics, and cars with better mileage • establishing recycling programs in schools • planting trees to remove CO_2

14. Global warming will increase the melting of the polar ice caps, thus introducing more water into the cycle. This may cause flooding of coastal areas. There will also be increased evaporation; so rainfall should increase somewhere. The increased heat will cause some areas to become deserts. Global agriculture may be changed radically.

15. Testing your hypothesis on a global scale is impossible. In the lab you could see what would happen to ice when it is exposed to higher temperatures. You also could observe the effect of increased humidity under different temperature conditions. You could actually make it rain! Unfortunately, the biosphere is so complex that testing just how all these factors will affect the entire globe is very difficult to do. This is why there is a great deal of concern about global warming.

Section 2: Follow-up Activities

Extra Help

1. Reducing waste will minimize the use of landfills where many elements are stored for a long time before they enter the cycle again. Reusing allows humans to get the maximum efficiency from a product and keeps the cycle going. Recycling ensures that the biogeochemical cycles will proceed at a natural rate.

2. This symbol can be found in many locations including the following:

   - paper products (newspapers, envelopes, books)
   - aluminum cans and plastic bottles
   - milk cartons and juice containers
   - recycling centres and boxes

3. Liquid water evaporates, cools in the air, and forms precipitation which falls to the Earth. Since most of the fresh water is ice, it must melt to enter this cycle of evaporation and precipitation.

4. Runoff is water that flows across the surface immediately after it rains. Some of it is absorbed and used by plants. This is capillary water. Gravitational water is runoff that seeps into the soil until it reaches the water table. Some of it will continue downward and become a part of the groundwater system or aquifer.

5. Urbanization has had a negative effect on the quality of water available for human consumption. This is a result of the pollutants that have been added to the water like bearing grease, oil, salt, garden fertilizer, pesticides, and heat. Agriculture has demanded large amounts of water through irrigation projects. Water returning from the fields has higher concentrations of fertilizer, salt, pesticides, and sulphates that contribute to poor water quality for humans. Recreational activities may lead to gasoline or oil spills that reduce the quality of the water further. Finally, weather patterns can change so there are sudden snowmelts or heavy storms that bring greater amounts of polluted water into the surface water supply. Acid rain is one example of poor water quality that can affect humans, animals, and plants.

6. This reaction is $6CO_2 + 6H_2O + \text{light} \longrightarrow C_6H_{12}O_6 + 6O_2$.

7. The carbon dioxide is found in the air. It may come from cellular respiration or from combustion.

8. This reaction is $C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{heat}$.

9. The carbon dioxide moves into the air. It could be used for photosynthesis, dissolve in water, or simply stay in the air and trap energy (heat).

10. The greenhouse gas (CO_2) buildup will retain more heat in the atmosphere. This could lead to global warming.

11. These bacteria convert animal and plant protein into ammonia (NH_3) and nitrates (NO_3) that can be used by plants. These processes are important to the basic nitrogen cycle.

12. Nitrates are important in the structure of amino acids that link together to form proteins. Proteins are found in the cell as structural molecules as well as biological catalysts. They are essential to the proper functioning of plant and animal cells.

13. The major human influence has been the use of fertilizers in agriculture. Excess nitrogen compounds enter the water supply. This has served to increase plant and algae growth. Decomposers use up more oxygen and release more carbon dioxide when decomposing this extra aquatic life. This leads to an oxygen depletion that kills fish and other oxygen-dependent organisms.

Enrichment

1. Here are some of the questions you could ask on your visit.

   - What is the quantity and composition of waste in your community?
   - How is your present system organized?
   - What is the local budget for solid waste management?
   - How much of the waste is placed in landfills?
   - What technology is used to prevent pollution from the landfill?
   - What is the life expectancy of your landfill?
   - Does your community have an incinerator?
   - What technology is used with the incinerator to recover energy?
   - What type of recycling program exists in your community?
   - How much is saved by recycling and avoiding the landfill?

2. The distribution of precipitation during the year is a major concern to farmers, builders, resort operators, and students. There are so many human activities that have an effect on weather. Of course, plants must have water to grow. Relative humidity affects evaporation significantly, so a review of this data will help you understand that the conditions in your area are a natural result of the water cycle.

3. There is a mini water cycle for all organisms. You take in water when you drink, eat, and soak in the bath. You lose water in your breath, urine, feces, and sweat. Perhaps more important in the biosphere is how much water you use in your daily activities such as watering your lawn, washing your food or clothes, showering, brushing your teeth, and flushing the toilet! Contact Alberta Environment and ask for the poster entitled *The Living Flow: Water in Alberta* to be sent to you. Then you will have a better idea of the human impact on the water value in Alberta.

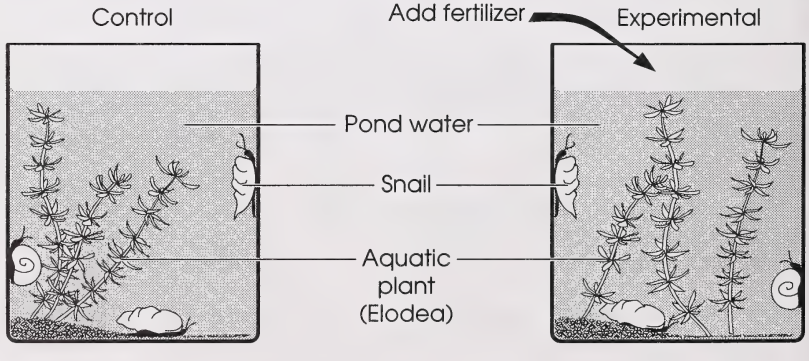
4. Burning fossil fuels for energy creates an imbalance in the carbon-oxygen cycle. The impacts include the following

   - air pollution
   - increased greenhouse effect
   - ozone depletion
   - water pollution

   A visit to an oil refinery would help you get the most up-to-date information about what is being done to reduce the problems.

5. A simple investigation may be undertaken using pond water, Elodea, and snails. Set up the apparatus as shown.

   Add one gram of fertilizer and observe each day for two weeks. Other experimental designs could examine the effect of different fertilizers. The best results will occur when you use fertilizers that do not have one of the nutrients: N = nitrates (nitrogen), P = phosphates (phosphorus), or K = potash (potassium). This will make it easier to identify the effect of each nutrient.



Section 3: Activity 1

1. The climatic factors include the prevailing weather conditions such as light, temperature, moisture, wind, and fire. The physiographic factors include latitude, altitude, and topography.

2. The edaphic factors may include the texture and chemical composition of the soil or the rock as seen in the diagram.

3. The abiotic factors will affect the type and number of living organisms that are found there. Ecosystems are recognizable by their producers or the type and number of plants that form the base of their trophic pyramids.

4. The rate of photosynthesis may decrease as plants receive less light through the cloud cover. There may also be an increase in the number of shade-tolerant plants with greater chlorophyll, greater leaf surface area, lower metabolic rates, and lower growth rates.

5. Since light does not penetrate water very well, it makes sense that plants must live near the surface to obtain enough light to photosynthesize and grow.

6. Plants and animals can survive between about +60°C and –60°C. They exhibit a variety of mechanisms that allow them to withstand the extremes of temperature that exist on the Earth.

7. Plants may have waxy leaves to reduce transpiration, deep roots to access the aquifers below them, and an increased ability to store water in their tissues. Animals will conserve water and try to retain what is taken into their bodies through their diet.

8. Wind can cause soil erosion, as well as tremendous heat loss and water loss from living organisms by convection and evaporation.

9. While fire may appear to be a negative force within an ecosystem, it can unlock the biomass of plants to the recycling processes. Certain seeds will not germinate without the heat of a fire. When controlled, fire can be an asset in forest management.

10. The duration and intensity of solar energy input decreases with any increases in latitude or altitude. This also influences the weather conditions. There is more wind and cooler temperatures as you move toward the Poles or up a mountain.

11. Your answer could be similar to the following chart.

Vegetation	Latitude
grasses and shrubs	30° N or S
deciduous trees	40° N or S
coniferous trees	50° N or S
high altitude conifers	60° N or S
alpine grasses	70° N or S
snow, and ice	90° N or S

12. The physical features of the land will affect the temperature primarily by altering the amount of solar energy that is available to the communities. The north slope of a hill will receive less sunlight; thus, the temperatures should be lower there than on the south slope. Also, the mountains or hills will cause winds to rise and cool. This will increase precipitation on the windward slope and cause dry conditions on the leeward slope. These abiotic changes will affect the variety of species in those parts of the ecosystem.

13. Soil is the layer of earth that supports plant growth. It contains the inorganic and organic material that plants need to live.

14. Soil is the site of decomposition which returns matter to the producers by the biogeochemical cycles. Since the bases of trophic pyramids consist of producers, it is essential that plants receive all the nutrients they require. These include water, carbon dioxide, oxygen, nitrates, and minerals such as magnesium, potassium, and calcium.

15. Fertile soil is characterized by ample amounts of dead organic matter that decomposers can transform into humus and inorganic ions. Water is an essential component of soil. Soil must also be aerated to allow the roots sufficient air for gas exchange to occur. Sand, silt, clay, and rocks form the texture of the soil and contribute to the air and water that can be trapped for plant use. Surface vegetation prevents soil erosion by wind, reduces the force of rain as it hits the soil preventing runoff, and adds to the humus when it dies and begins to decompose. These edaphic factors serve to increase the fertility of soil.

16. **Textbook question 1:** Figure 5.2 on page 156 of your textbook shows you how to draw a labelled map. Your answer should follow this format.

    Textbook question 2: Your data could be presented in a chart like the one that follows.

	Site 1	Site 2	Site 3
type of ground	clay	clay	clay
depth of water	0.5 m	0.3 m	1.2 m
speed of water	3 km/h	3 km/h	2 km/h
pH of water	6.7	6.7	6.9
temperature of air	18°C	18°C	17°C
amount of solar radiation	high	high	moderate
compass direction	stream flow is 75° W of N	stream flow is 90° to N	stream flow is 120° W of N

Textbook question 3: Your diagram should be similar to Figure 5.1 on page 154 of your textbook.

Textbook question 4: Your description should include any living and non-living things you noted that you feel are important in this particular ecosystem.

17. **Textbook question 2:** Your list of plants and animals may include various grasses, shrubs, trees, water plants, frogs, tadpoles, fish, and insects, depending on whether you studied an aquatic system, a terrestrial system, or both.

Textbook question 5: Temperature and pH affect the aquatic community as each type of organism will have a range of temperature and pH that is compatible with its metabolic processes. When these factors are significantly altered, some organisms may die or move, while others with ranges that suit the new environment will move in to occupy it.

Textbook question 8: A bank or ground that has little vegetation cover will erode more easily. Good quality soils will grow plants with well-developed root systems. This will minimize erosion.

Textbook question 14: An ecosystem is in a balanced state such that all living organisms have adapted to the abiotic environment. Any drastic changes in that environment will have consequences. If the change is long-term, then a new balance will be established in which organisms that can tolerate the new conditions flourish while others are lost from the ecosystem.

Textbook question 16: Answers will vary. The various abiotic factors influence the number and types of organisms found in a particular ecosystem. The organisms also have an effect on the abiotic factors. These effects include damage to plants which might increase soil erosion and solid compacting as well as excretions which may improve soil conditions, and so on.

18. **Textbook question 1:** Your answer should reflect the conditions in your area.

Textbook question 2: Figure 5.3 on page 157 of your textbook shows you how to answer this question. Your answer should be similar.

Textbook question 3: Your data could be presented in a chart like the one that follows.

	Site 1 (sun)	Site 2 (shade)
wind speed and direction	15 km/h from south west	15 km/h from south west
air temperature	23°C	21°C
solar radiation	high	moderate
moisture in soil	low	moderately moist
type of soil	sandy, black soil	sandy, black with mossy surface layer

Textbook question 4: Your description should include any living and non-living things you noted that you feel are important in this particular ecosystem.

19. **Textbook question 2:** Your list of plants and animals may include various grasses, shrubs, trees, water plants, frogs, tadpoles, fish, and insects, depending on whether you studied an aquatic system, a terrestrial system, or both.

    Textbook question 9: Wind will blow away topsoil, affect moisture levels, bend plants that are present, and affect the rate of transpiration in plants.

    Textbook question 10: Temperatures will affect the success rates of plants and insects in particular. This in turn will affect organisms that are higher in the food chain.

    Textbook question 11: Soil moisture and type of soil will affect plants, insects, and animals in a terrestrial ecosystem. Some plants require very moist conditions while others can survive in poor quality soils with low moisture levels.

    Textbook question 12: Answers will depend on your particular site. Note evidence of water and wind erosion. Vegetation is a major factor in erosion.

    Textbook question 14: An ecosystem is in a balanced state such that all living organisms have adapted to the abiotic environment. Any drastic changes in that environment will have consequences. If the change is long-term, then a new balance will be established in which organisms that can tolerate the new conditions flourish while others are lost from the ecosystem.

    Textbook question 16: Answers will vary. The various abiotic factors influence the number and types of organisms found in a particular ecosystem. The organisms also have an effect on the abiotic factors. These effects include damage to plants which might increase soil erosion and solid compacting as well as excretions which may improve soil conditions, and so on.

20. Your diagram should be similar to the one on page 156 of your textbook, but include the characteristics of your site.

21. Your diagram should be similar to the one on page 154 of your textbook, but include the characteristics of your site.

22. Your description should include any living and non-living thing you noted that you feel is important to this particular ecosystem.

23. Refer to the answers provided for Section 3, Activity 1, question 17.

24. Your diagram should be similar to the one on page 157 of your textbook, but include the characteristics of your site.

25. Your description should include any living and non-living thing you noted that you feel is important to this particular ecosystem.

26. Refer to the answers provided for Section 3, Activity 1, question 19.

Section 3: Activity 2

1. The abiotic factors restrict the number and types of organisms that are able to survive in a particular environment. In this way they limit the nature of the ecosystem. There is often competition among the species for such abiotic factors as light, temperature, water, wind, and soil. Even one of these factors may be the limiting factor.

2. The nature of food chains, webs, and pyramids will determine how many organisms at each level can be supported in an area. This produces a specific area that is identifiable as a biome.

3. The most important limiting factor would have to be water. Without this vital fluid, the living organisms could not survive. The nature of the soil also has a great impact on the plants that can grow in a particular area.

4. The most important limiting factor in an aquatic ecosystem is light. Solar energy is used for photosynthesis which helps plants form the base of the trophic pyramids. Appropriate temperatures are also important to allow the living organisms to function properly. The amount of water is also an important limiting factor in this ecosystem.

5. The boundary line between biomes exists because there are changes in climate which influence the vegetation of adjacent areas. For the tundra boundary line to be extended, there would have to be generally colder temperatures, less precipitation, and a wider variation in winter and summer temperatures. For the rain forest boundary line to be extended, the climate would have to change in an opposing way. This means that there would have to be generally warmer temperatures, a great increase in precipitation, and very little change in temperature between winter and summer.

6. The most prominent biomes in Alberta are the boreal coniferous forest and grassland. There will be many ecosystems within each of these biomes, especially aquatic ecosystems like ponds, lakes, and rivers.

7. You may have had the opportunity to visit the tundra of Northern Canada, the temperate rain forests of British Columbia, or the temperate deciduous forests of Eastern Canada. The Rocky Mountains, the chaparral areas of British Columbia, and the deserts of the Southern States may be other biomes you have visited.

8. The biomes of Alberta are influenced most by temperature, precipitation, and soil composition.

9. The heaviest precipitation in Prince Rupert fell in October (34 cm), and in Yellowknife the heaviest precipitation fell in July (4 cm).

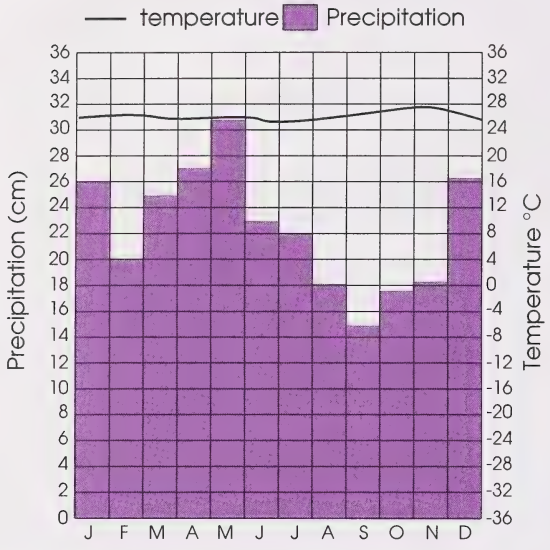
10. August (12°C) is the warmest month in Prince Rupert, while July (18°C) is the warmest in Yellowknife.

11. Prince Rupert is about 26°C warmer than Yellowknife in January.

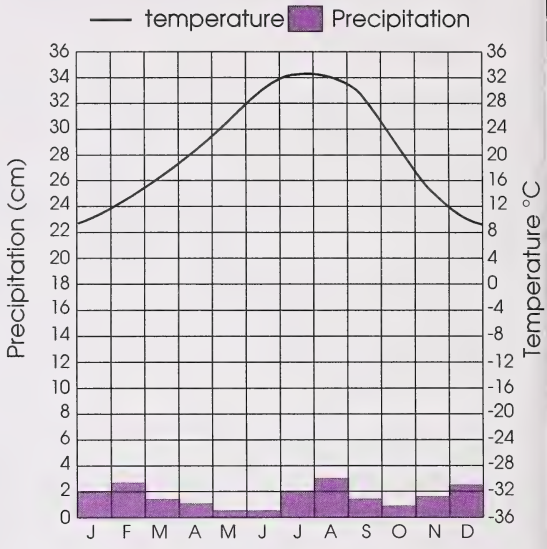
12. The limited variation in temperature and high precipitation in Prince Rupert contribute to the tremendous growth of plants that is found in a rain forest. Yellowknife is very dry and the temperatures vary greatly; thus, it will not support as much plant life. It is very close to the treeline, so the only trees that can survive there are conifers.

13. Your climatograms should look like the ones that follow.

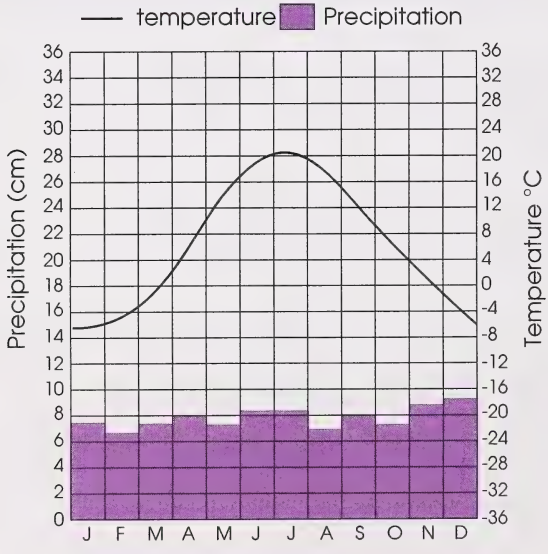
Biome A



Biome B



Biome C



14. Your chart should be completed like the one that follows.

Condition	Biome Best Fits	Why
closest to equator	A	constant temperature
seasonal temperature changes	C	wide variation
longest growing season	A	year-round
highest annual precipitation	A	greatest total
measurable snowfall	C	temperature below 0°C
driest soil	B	lowest precipitation
greatest variety of plants	A	best conditions
resembles the biome near you	C	appears like Alberta conditions

15. The data for Climatogram A best describes the tropical rain forest. Climatogram B best describes the desert, and Climatogram C is the boreal coniferous forest.

Section 3: Activity 3

1. Other human activities that contribute to problems in the environment might include the following:

   - improper use of fertilizers and pesticides that degrade wildlife
   - hydroelectric developments that divert the natural water flow
   - petroleum developments that damage aquatic ecosystems
   - acidic deposits that leach nutrients from the soil

2. Each of these are examples of human attempts to restore the natural conditions that should exist in ecosystems. While human activities can damage the environment, they can also improve it.

3. Since it is the function of the environment to produce the habitat for living organisms, the preservation of the abiotic factors in ecosystems is essential to support endangered species. The balance in nature is only possible when conditions are as natural as possible.

4. The wetlands biome is the most productive biome because it is able to produce the greatest biomass with the greatest energy stored.

5. The desert has the lowest biomass and the lowest energy stored. With very little water available to the producers, the radiant energy of the sun is not able to sustain life.

6. While both biomes are characterized by trees, the weather conditions in the coniferous forest are much harsher. The trees must use more energy to survive the cold temperatures and search out the limited water supplies. Therefore, they cannot store as much energy in their tissues. The coniferous trees are often larger than the deciduous trees, which accounts for the greater biomass.

7. The oceans form a very stable biome. This stability allows the small algae to flourish without using much energy to live. Much of the solar energy trapped in the photosynthetic process can be stored and passed up the food chains. The salinity contributes to fewer organisms; so the biomass is low.

8. The wetland destruction has occurred because of the following:

   - the building of cities
   - the building of highways
   - drainage for agricultural purposes
   - the ploughing of nesting sites
   - overgrazing by domestic cattle

9. The three management strategies are as follows:

   - Preservation of the wetland will maintain the conditions as they are currently by protecting it from destructive intrusions.
   - Restoration will bring the wetland back to its former condition before any destructive intrusion.
   - Enhancement, such as the addition of nesting sites, will add to an already existing site to improve wildlife production.

10. Nathan was from the Brooks area and researched an area in Kitsum and Antelope Creek. He found that the river basins could be irrigated to improve wetland habitat. Also, overgrazing was a problem that could be overcome by limiting the range movements of cattle and allowing native grass a chance to grow. This could provide nesting sites for about five to six weeks in the spring. The ranchers would benefit with better grazing land and waterfowl could achieve their nesting potential. Katie was from Edmonton and researched an area in the Buffalo Lake region. She found that nesting sites needed protection. If the farmers reduced their cultivation and left a suitable area around pond margins for ducks to nest, then more nesting sites could be available. She found that clover and hay provide good nesting sites. The land around the potholes could be managed more effectively. Chris was from the Peace Country and researched an area near Kleskun Lake. He found that this area occupied about 7500 hectares at the turn of the century. It was an important staging and moulting area for waterfowl. Drainage of this region had dried out parts of the lake and flooding was the result over a number of years. The solution appeared to be a dike to store water in the spring. Then, the water could be slowly released to maintain the wetland, thus saving a valuable habitat and allowing the birds to return in significant numbers.

11. Nathan could use enhancement in the Kitsum and Antelope Creek area to improve the quality of wetlands there. Katie could use preservation to keep the wetland habitat from producing endangered species of waterfowl. Chris actually researched a restoration project. This project was successful in returning the wetland area to its former state with abundant waterfowl.

12. The final message suggests that wetlands can be managed properly. If human activity maintains the wetlands, they will add to the quality of life within the grasslands biome.

13. The grasslands are located in the southern part of the prairie provinces (Alberta, Saskatchewan, and Manitoba).

14. Research studies at the University of Saskatchewan suggest that only 1% to 5% of the plains fescue (tufted, short grasses) and less than 1% of the tall-grass areas can still be found in the grasslands.

15. The human activities that have contributed to the destruction of the prairie grasslands are as follows:

    a. Agriculture has converted about 87% of grasslands into farmland. There has been a significant loss of organic matter and plant nutrients from the soil.

    b. Natural water systems have been extensively modified and used for hydroelectric and thermal power generating plants, irrigation projects, flood protection, and water management.

    c. Irrigation accounts for 46% of the water withdrawn from the grasslands. It also accounts for 69% of the total water consumption in that area. This can cause a competition for water among the communities of this biome.

    d. Draining sloughs lowers the water table. Water levels are close to a bare minimum to support life. Climate, as well as socio-economic reasons, make this situation critical in the grasslands of Western Canada.

    e. Urbanization has swept much of the grasslands under the carpet of houses, roads, parks, and other buildings.

Section 3: Follow-up Activities

Extra Help

1. Your organization of the terms should follow this chart.

ABIOTIC FACTORS WITHIN ECOSYSTEMS		
Climatic	**Physiographic**	**Edaphic**
air	altitude	chemicals
light	latitude	soil texture
moisture	topography	
temperature		
wind		

2. As the temperature goes down, all the plants and animals will begin to adapt. Some will reduce their activity level in anticipation of a dormant stage in their development. Some will change physically to adapt to the loss of energy and will actually increase their activity.

3. Increased acidity of the soil may cause plant growth to be impaired. The chemical weathering of the soil may also be increased, thus leaching the soil of important nutrients that plants need to survive.

4. One example of altitude affecting vegetation is the treeline. The cold temperatures and insufficient water above this height mean that trees cannot grow. Another example is the absence of grasslands above a certain altitude. Again, the temperature and amount of precipitation will not allow the grass to grow there.

5. Since these two locations are found at the same latitude, you would expect them to get about the same amount of sunlight per day throughout the year. It is possible, therefore, that they might have the same average daily temperature and average precipitation.

6. These locations may not be at the same altitude, which will affect the climate that each one experiences. The precipitation and the quality of the soil, are probably very different, since one is a grassland and the other is a temperate deciduous forest.

7. The quality of water is influenced greatly by human activities including waste disposal, chemical and thermal pollution, and mining operations which add heavy metals and acids to the water. Water quality can also be affected by naturally occurring impurities like calcium, magnesium, sodium, and potassium which increase the hardness of the water.

8. Generally, the impact of human activity has been negative. The wetlands and grasslands have been sacrificed to allow for urbanization, agriculture, recreation, mining, logging, and other economic developments. However, you should remember that what humans can destroy, they can also restore, preserve, and enhance. The future can be positive if more people become involved in keeping the wetlands and grasslands of Alberta in their natural state.

Enrichment

1. While the federal government has a leadership and advisory role in drinking water quality, Alberta has legislation that outlines the standards for drinking water quality. You can obtain information about those laws from your MLA or you may visit your local water treatment plant to find out exactly what is being done in your area. If you are living on a farm, check with your local district agriculturalist for information about rural drinking water quality.

2. Using the map found in Figure 3.11 of this module, you can identify whether you live in the grassland or boreal forest portion of Alberta. A sample climatogram for the boreal forest (Yellowknife) is found in Figure 3.13 of this module, and a sample climatogram for the grassland is found in Figure 3.14.

3. It is important to note that steps are being taken to restore the natural environment of Alberta. Many initiatives have proved to be very successful. As a result, there is hope for the future! You may wish to start a club at your school with your visual display as the first step. You may wish to simply encourage local awareness during Education Week by posting your visual display in a prominent place.

4. To find out what the Province of Alberta is doing to manage the wetlands, you could contact the Environment Council of Alberta at the following address:

   4th Floor, 9925 - 109 Street
   Edmonton, Alberta
   T5K 2J8
   Phone: (403) 427-5792

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